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Pemberton hydroelectric power station: a teacher resource

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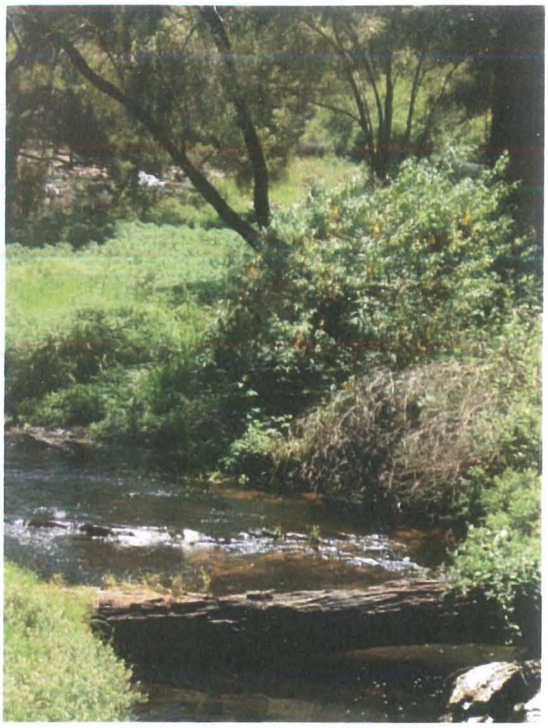

Pemberton

Hydroelectric Power Station

A Teacher Resource

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A job at the State Saw Mill is extracted from the private publication of Mr Ron Hutchins. *Northcliffe & Pemberton: a south west saga.*

(Note: We have been unable to locate Mr Hutchins. If you or members of his family

Water cycle diagram (Lesson One of science Unit) courtesy of the U.S. Geological Society (http://www.usgs.gov/).

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Introduction

This publication provides a resource for teachers of students in years seven to ten. Teachers are able to address a range of outcomes pertinent to the Western Australian curriculum within the context of the Pemberton Hydroelectric Power Station. The resource contains plans for four units of work, one in each of the following Learning Areas: Science, Mathematics, English, and Society and Environment.

The units of work were collaboratively developed following an 'outside-in' approach. This begins with a mindmap of the concepts that a teacher might consider important for students to learn about, or through the opportunities offered by, a particular theme – in this case, the Pemberton Hydroelectric Power Station. (This resource contains examples of two mindmaps: one on electrical power, and the other on the Greenhouse effect.) From this frame, key ideas are selected in order to achieve desired outcomes for a particular class and in accordance with the level of development of the students. A pathway of learning experiences which would provide students with appropriate opportunities to develop the knowledge, skills and understandings is then developed. The two learning pathways offer a large range of ideas through which to achieve particular outcomes.

The unit plans provided convert the ideas in the learning pathways into a coherent unit of work. The plans are based on the 5Es framework of Engage, Explore, Explain, Elaborate, and Evaluate, and contain ideas for lessons at each phase. The first lesson for each unit is provided in full.

Further information and teacher support resources can be accessed from the websites provided at the back of the resource.

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Pemberton hydroelectric power station – Background Information

Today, Western Power provides electricity to the South West region of Western Australia. However, in the first half of the 20th century Pemberton relied on local resources to generate electricity. During winter, Pemberton Power Supply, a privately owned company, provided electricity through a hydroelectric power station and, in summer, the local timber mill generated power via boilers and diesel engines. Combined, the hydroelectric station and the timber mill ensured that Pemberton was self-sufficient in terms of energy supply.

The hydroelectric power station, built in 1935, was run by Pemberton Power Supply until it was purchased by the State Energy Commission (SEC) in 1950. During this time the South West Integrated Supply broadened their service throughout the South West region. They offered to integrate Pemberton into the South West Power Scheme, rendering the hydroelectric station only necessary as a supplement to the energy provided by the state.

In the early 1950s, a severe storm swept through Pemberton, causing several large karri trees to smash through the pipeline. As a result, the station was decommissioned in 1953 and Pemberton was forced to rely completely on the state power grid for its electricity. Over half a century later, Pemberton still relies on the state and there has been no need for a subsequent power source. As such, it wasn't until the late 1990s, and for completely different reasons, that a proposal to reconstruct the hydroelectric station was put forward.

The South West Development Commission oversaw the construction of the new hydroelectric station which began operating in August 2006. Located two and a half kilometres north of Pemberton, at the original site of Lefroy Brook, the new hydroelectric station generates enough energy to supply power to up to 80 houses daily. The station's day-to-day operations are monitored by a contractor and power generation is pre-programmed to commence once the water in the dam reaches a set level. As such, although energy output is determined by the changing stream flow during winter, it is expected that the station will be capable of producing between 200-350,000 kWh each year.

Construction

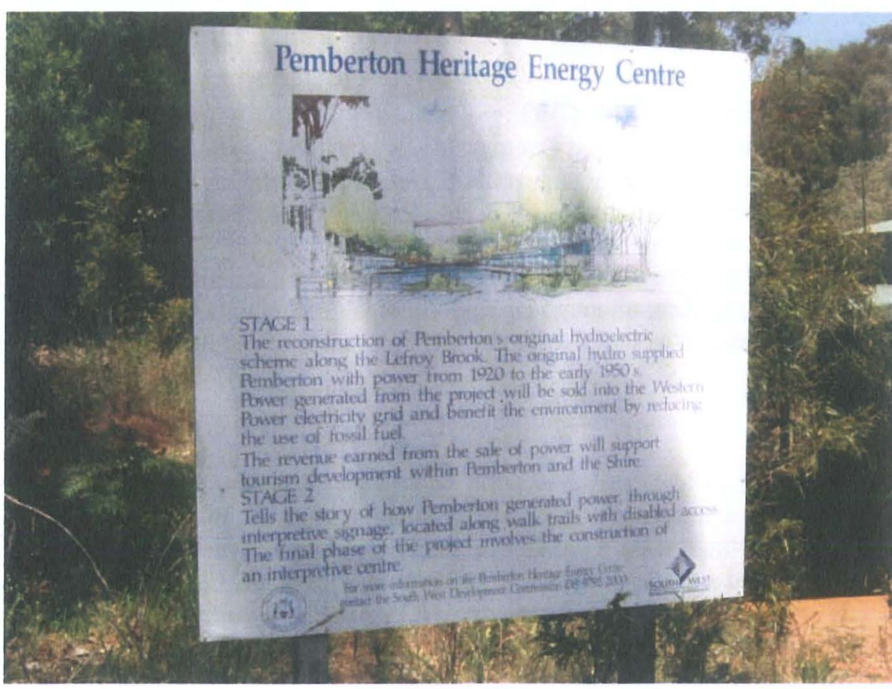
In Western Australia, there have only been three publicly owned hydroelectric plants - Pemberton, Ord River, and Wellington Dam - and of these, the Pemberton hydroelectric power station is the only one to have had a timber pipeline. Widely recognised as the home of the karri tree, Pemberton utilised this renewable resource, constructing 1ft by 6ft karri boards to be held in place with steel strapping. Resembling an oak wine barrel, the timber pipeline carried water a total of 450 metres between the Pemberton Weir and a turbine station.

In contrast, construction of the current hydroelectric station required installation of a lobster tail intake, a 103kWh Kaplan turbine, concrete housing station, power mains connection to the South West Integrate Supply, and reinstatement of alignment. The pipeline is constructed with 450 metres of 800mm diameter high density poly ethylene (HDPE) pipe which diverts the water from Lefroy Brook, through the turbine, and then back through the pipeline. Water is only extracted from the brook between May and October, providing the water reaches a predetermined trigger point, which is governed by the amount of overflow over the Pemberton Weir wall. Operations of the hydroelectric station are run by remote telemetry systems with a trigger mechanism that initiates the station to commence producing power once sufficient water is available.

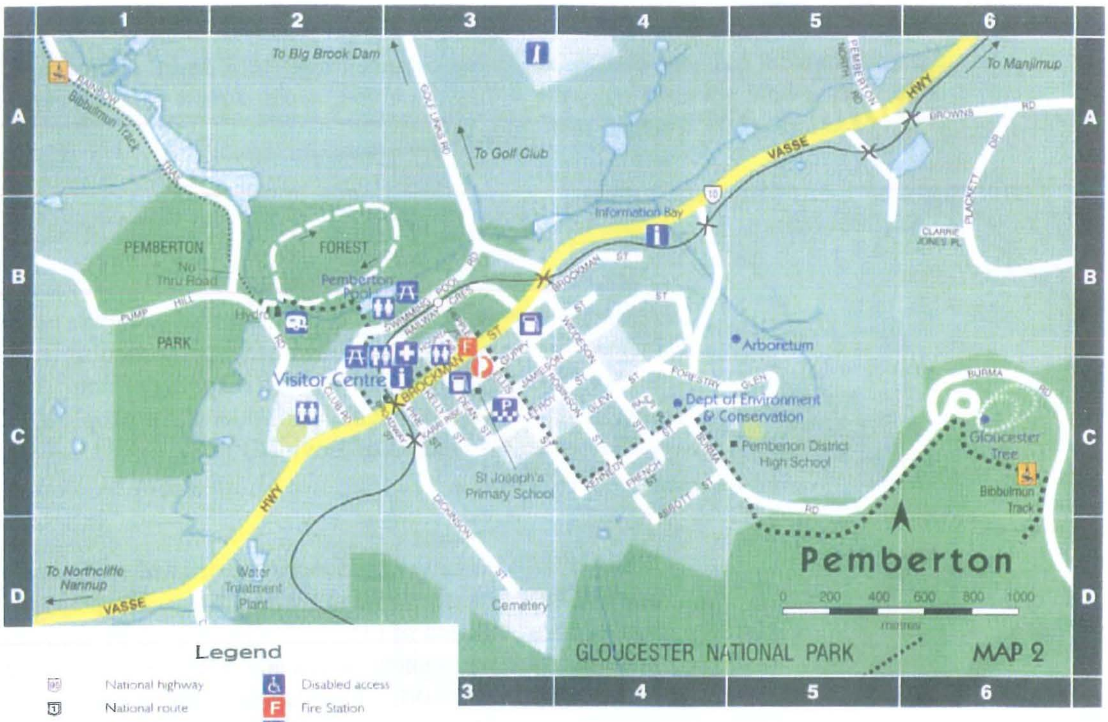
Current Management

The Pemberton Hydro Energy Association (PHEA), a local committee associated with the WA Community Foundation, manages the station's operations and its contribution to the local community in collaboration with the South West Development Commission. Contractually, the PHEA has the right to sell all energy output as well as any Renewable Energy Certificates (RECs) earned because of its production of 'Green energy'. The Pemberton hydroelectric power station is registered with the federal government's Office of Renewable Energy Regulator (ORER), who is responsible for monitoring claims of green energy production. Producing carbon dioxide (CO2) free power allows the hydroelectric station to claim 'green credits', Renewable Energy Certificates, which are a form of electronic currency. The price of RECs varies because sellers and purchasers directly negotiate price and payment methods. The Pemberton Hydro Energy Association trades RECs with Synergy to recover costs incurred in operating the hydroelectric plant and directs surplus profits to the Future of Pemberton Trust Account. This trust fund is used to support non-profit community projects such as aged care, public amenities, and youth services.

In addition to its contributions towards the local community and the supply of power to the state electricity grid, the hydroelectric station is included as one of the town's tourist attractions. On one level, it is symbolic of the region's industrial heritage providing an important insight into the history of the town. On another level, the new power station serves to raise awareness of environmentally safe procedures: i.e. the generation of power without carbon emissions through the natural movements of water in river systems. Thus, Pemberton hydroelectric power station stands as a testament to both the past and the future.



Town of Pemberton



Southwest of Western Australia

Outline of Curriculum Materials

This curriculum document has been constructed using a theme based 'outside-in' approach. It can be approached from several points of entry depending upon your needs. Below is an overview of each of the main sections of the teaching materials.

Teaching and Learning Materials

MINDMAP

A map of key ideas that *could* be addressed using the central theme. The mapping is *not* concerned with particular Learning Areas; rather, it provides a mapping of non-disciplinary ideas that might be considered for people to understand. (Two maps are provided)

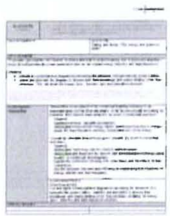
LEARNING PATHWAY

A pathway of learning experiences constructed using one or more of the ideas generated in the Mindmap. The pathway represents a selection of topics, ideally, chosen by the teacher to reflect the development, needs and interests of the students in that particular cohort. (Two pathways are provided)

UNIT PLANS OVERVIEW

An overview of the four units of work produced for this curriculum package: English; Mathematics; Science; and Society and Environment. (Note: for this project, the units presented are drawn from both of the pathways above).

UNIT PLANS

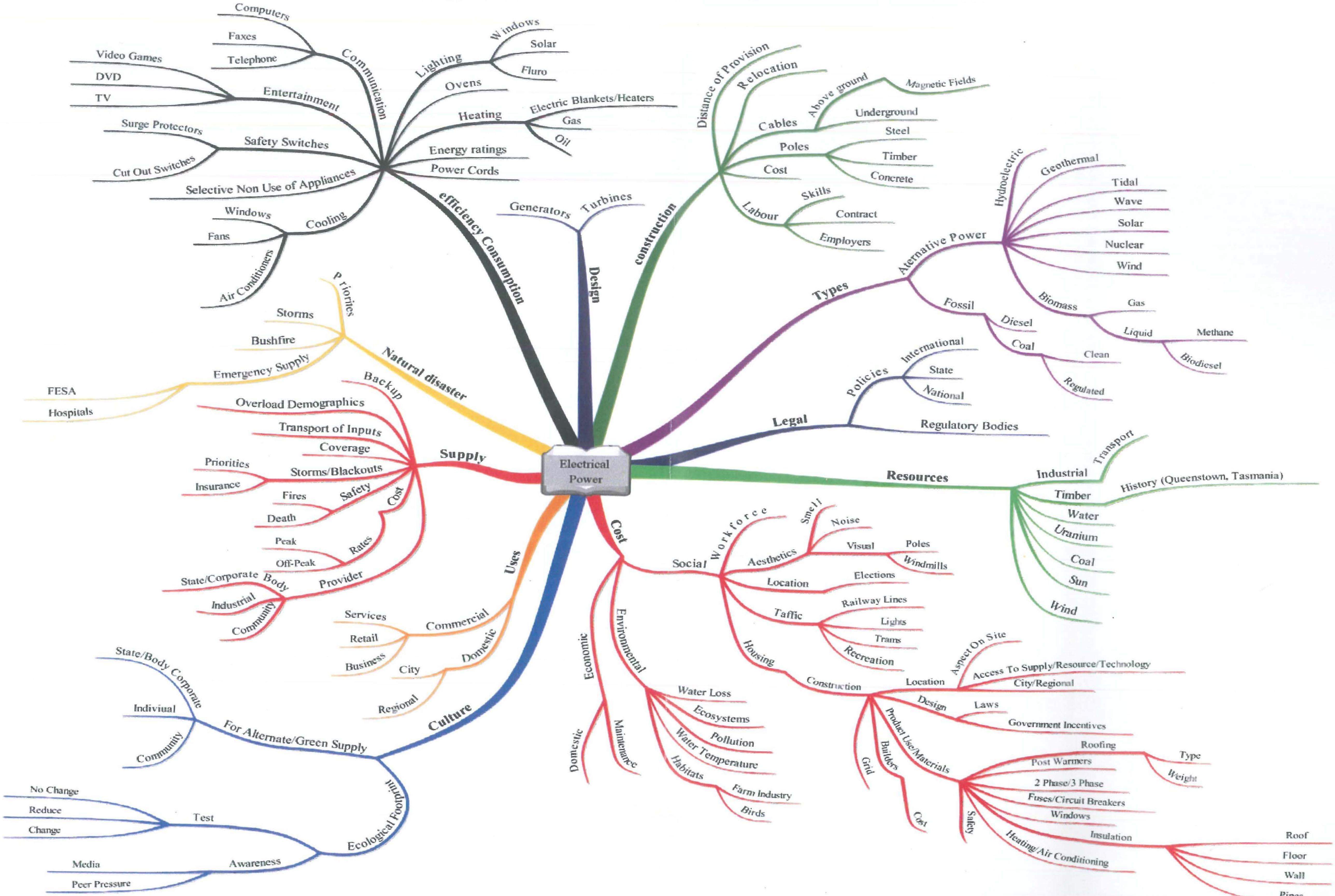


Plans for units of work based on one of the Learning Experiences from the Learning Pathway. This unit is aimed at achieving learning outcomes within a particular Learning Area. The sequence of lessons follows the 5Es Teaching Model and includes several Diagnostic, Formative and Summative assessment ideas.

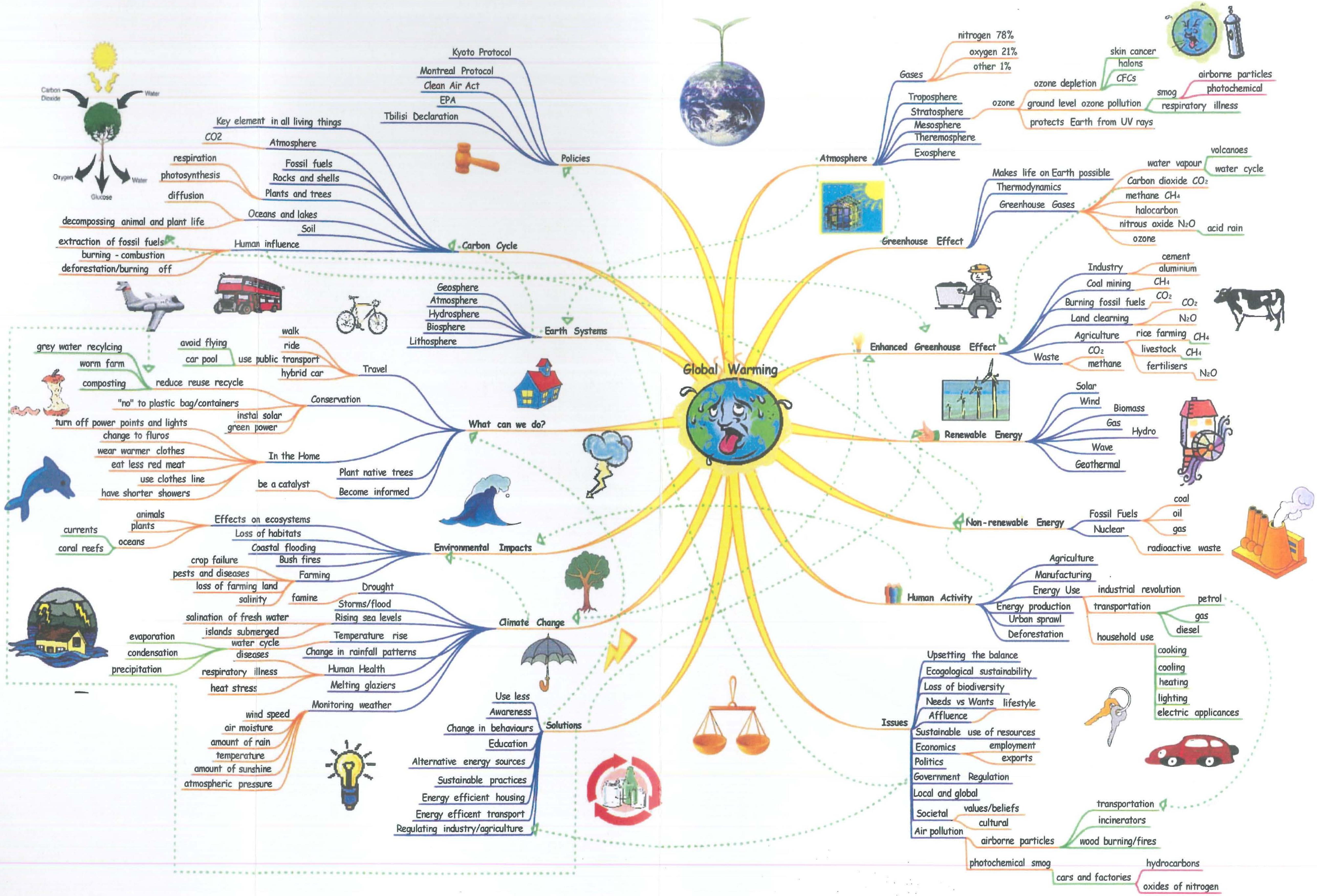
LESSON PLAN

Detailed lesson plans for the first lesson of each unit.

Note: See Australian Institute of Energy website for a Fact sheet on Hydroelectric Power. (http://www.aie.org.au/facts_index.htm)



Electrical Power
efficiency Consumption
Communication
Computers
Faxes
Telephone
Entertainment
Video Games
DVD
TV
Safety Switches
Surge Protectors
Cut Out Switches
Selective Non Use of Appliances
Cooling
Windows
Fans
Air Conditioners
Lighting
Windows
Solar
Fluro
Ovens
Heating
Electric Blankets/Heaters
Gas
Oil
Energy ratings
Power Cords
Design
Generators
Turbines
construction
Distance of Provision
Relocation
Cables
Above ground
Magnetic Fields
Underground
Poles
Steel
Timber
Concrete
Cost
Labour
Skills
Contract
Employers
Types
Alternative Power
Hydroelectric
Geothermal
Tidal
Wave
Solar
Nuclear
Wind
Biomass
Gas
Liquid
Methane
Biodiesel
Fossil
Diesel
Coal
Clean
Regulated
Legal
Policies
International
State
National
Regulatory Bodies
Resources
Industrial
Transport
Timber
History (Queenstown, Tasmania)
Water
Uranium
Coal
Sun
Wind
Cost
Social
Workforce
Aesthetics
Smell
Noise
Visual
Poles
Windmills
Location
Elections
Taffic
Railway Lines
Lights
Trams
Recreation
Housing
Construction
Location
Aspect On Site
Access To Supply/Resource/Technology
City/Regional
Design
Laws
Government Incentives
Product Use/Materials
Roofing
Type
Weight
Post Warmers
2 Phase/3 Phase
Fuses/Circuit Breakers
Windows
Insulation
Roof
Floor
Wall
Pipes
Heating/Air Conditioning
Safety
Grid
Builders
Cost
Environmental
Water Loss
Ecosystems
Pollution
Water Temperature
Habitats
Farm Industry
Birds
Economic
Domestic
Maintenance
Culture
For Alternate/Green Supply
State/Body Corporate
Indiviual
Community
Ecological Footprint
Test
No Change
Reduce
Change
Awareness
Media
Peer Pressure
Uses
Commercial
Services
Retail
Business
Domestic
City
Regional
Supply
Backup
Overload Demographics
Transport of Inputs
Coverage
Storms/Blackouts
Priorities
Insurance
Safety
Fires
Death
Cost
Rates
Peak
Off-Peak
Provider
Body
State/Corporate
Industrial
Community
Natural disaster
Priorities
Storms
Bushfire
Emergency Supply
FESA
Hospitals


Global Warming
Carbon Dioxide
Water
Oxygen
Glucose
Water
Policies
Kyoto Protocol
Montreal Protocol
Clean Air Act
EPA
Tbilisi Declaration
Carbon Cycle
Key element in all living things
CO2
Atmosphere
Fossil fuels
Rocks and shells
Plants and trees
respiration
photosynthesis
diffusion
Oceans and lakes
decomposing animal and plant life
Soil
Human influence
extraction of fossil fuels
burning - combustion
deforestation/burning off
Earth Systems
Geosphere
Atmosphere
Hydrosphere
Biosphere
Lithosphere
What can we do?
Travel
walk
ride
use public transport
avoid flying
car pool
hybrid car
Conservation
reduce reuse recycle
grey water recycling
worm farm
composting
"no" to plastic bag/containers
instal solar
green power
In the Home
turn off power points and lights
change to fluros
wear warmer clothes
eat less red meat
use clothes line
have shorter showers
be a catalyst
Plant native trees
Become informed
Environmental Impacts
Effects on ecosystems
animals
plants
oceans
currents
coral reefs
Loss of habitats
Coastal flooding
Bush fires
Farming
crop failure
pests and diseases
loss of farming land
salinity
Climate Change
Drought
famine
Storms/flood
Rising sea levels
salination of fresh water
islands submerged
Temperature rise
water cycle
evaporation
condensation
precipitation
Change in rainfall patterns
diseases
Human Health
respiratory illness
heat stress
Melting glaziers
Monitoring weather
wind speed
air moisture
amount of rain
temperature
amount of sunshine
atmospheric pressure
Solutions
Use less
Awareness
Change in behaviours
Education
Alternative energy sources
Sustainable practices
Energy efficient housing
Energy efficent transport
Regulating industry/agriculture
Atmosphere
Gases
nitrogen 78%
oxygen 21%
other 1%
Troposphere
Stratosphere
Mesosphere
Theremosphere
Exosphere
ozone
ozone depletion
skin cancer
halons
CFCs
ground level ozone pollution
smog
airborne particles
photochemical
respiratory illness
protects Earth from UV rays
Greenhouse Effect
Makes life on Earth possible
Thermodynamics
Greenhouse Gases
water vapour
volcanoes
water cycle
Carbon dioxide CO_2
methane CH_4
halocarbon
nitrous oxide N_2O
acid rain
ozone
Enhanced Greenhouse Effect
Industry
cement
aluminium
Coal mining
CH_4
Burning fossil fuels
CO_2
CO_2
Land clearning
N_2O
Agriculture
rice farming
CH_4
livestock
CH_4
fertilisers
N_2O
Waste
CO_2
methane
Renewable Energy
Solar
Wind
Biomass
Gas
Hydro
Wave
Geothermal
Non-renewable Energy
Fossil Fuels
coal
oil
gas
Nuclear
radioactive waste
Human Activity
Agriculture
Manufacturing
Energy Use
industrial revolution
transportation
petrol
gas
diesel
household use
cooking
cooling
heating
lighting
electric applicances
Energy production
Urban sprawl
Deforestation
Issues
Upsetting the balance
Ecogological sustainability
Loss of biodiversity
Needs vs Wants
lifestyle
Affluence
Sustainable use of resources
Economics
employment
exports
Politics
Government Regulation
Local and global
Societal
values/beliefs
cultural
Air pollution
airborne particles
transportation
incinerators
wood burning/fires
photochemical smog
cars and factories
hydrocarbons
oxides of nitrogen

Theme: Hydroelectric Power

Introductory Learning Experience 1

EXCURSION TO PEMBERTON

Learning Experience 2

WHY RENEWABLE ENERGY?

Emissions – What are they? Read & answer activity
Ecological Footprint: Calculate your print
Alternative energy sources: Group fact sheet activity
Similarities & differences: renewable & non-renewable energy

Learning Experience 3

HYDRO-ELECTRICITY AND THE NATURAL ENVIRONMENT

- Pre-construction: River use & existence pre-dam. View aerial map of non-dammed river – what is it used for? 100% undisturbed, etc.
- Construction – Draw map (using aerial photo) to map land disturbance during construction.
- Ecosystems: What are ecosystems? Draw in contributors of the ecosystem as a class. Groups look at separate parts of the map

Learning Experience 4

ENVIRONMENTAL AUDITS & STUDIES

- Why are audits and studies carried out?
- Do your own investigation on plants, birds, animals, soil, insects and/or frogs:
- Sample grid – pairs 1m². Identify plants, numbers of species and take measurements
- Assessing information and decision making. How diverse is this area? Justify in written dialogue.

Learning Experience 5

ENVIRONMENTAL AUDIT AND STUDIES - WATER

- The water cycle ☺1
- Our changing ecosystem. ☺2
- Hydrology experiments and understanding. ☺3
- Marine life up and down stream. ☺4
- Mini-cultural study: Research past culture, spirituality, cultural perspective. Guest speaker.

Learning Experience 6

THERE'S POWER IN WATER?

- What is potential energy? Experiment
- How is the energy released? Removing the barrier holding back the kinetic energy
- Looking at the power of water in floods, tsunami's, etc. Before and after activity - how powerful is water, with movie/animation

Learning Experience 7

HOW DOES A HYDRO-ELECTRIC PLANT MAKE POWER?

- Water moved from the dam – What is gravity? Harnessing water – investigation, time water flowing through a pipe, collect data and graph
- Water turns turbine – conversion of water from kinetic to mechanical energy. Make a crude construction of a turbine.
- Turbine turns motors – conversion of water from mechanical to electrical energy: Basic animation and worksheet

Learning Experience 8

DESIGN AND MAKE A HYDROELECTRIC MODEL

- Design and make a hydroelectric model. ☺5

Learning Experience 9

OUR ELECTRICITY SYSTEM

- Trace the travel of power from the switch back to the source: diagrammatic representation
- The electrical grid system: Guest speaker/ model railway analogy
- How much electricity do we use? – survey/research activity
- Reading or video of pioneer without power.
- Overload, blackouts, peak-periods, back-up supply:
- Narrative – one day in your life without power.

Learning Experience 10

ELECTRICITY OF THE PAST & FUTURE

- History of Electricity – timeline ☺6
- Past, present & future requirements ☺7
- Inventory of electrical usage in the school. ☺8
- Changing lifestyle and demographics over time. ☺9

Learning Experience 11

HYDRO-ELECTRIC POWER IN THE FUTURE/CLIMATE CHANGE

- Types of power stations. ☺10
- Debate location of potential power stations. ☺11
- Macro and mini power plant – exploring the concept of a community electricity supply. Investigate constancy of supply

Learning Experience 12

GLOBAL CONNECTIONS / WHERE IS SUITABLE FOR HYDRO-ELECTRICTY

- Rainfall study ☺12
- Topographical connections ☺13

Learning Experience 13

ELECTRICITY CONSERVATION: Activities

- Energy conservation – design and make a board game. ☺14
- Power conservation – suggesting ways to change ☺15

Learning Experience 14

COSTS/BENEFITS OF HYDRO-ELECTRICITY

- Economical resource use ☺16
- Value dilemmas ☺17
- Economic cost of the hydro plant ☺18
- Social and environmental cost of hydroelectricity ☺19
- Beliefs and values ☺20

Learning Experience 15

MARKETING HYDRO-ELECTRICITY

- Marketing hydro electric power – benefit or harm ☺21
- Marketing hydro electric power – Selling the concept ☺22
- Marketing hydro electric power – For the community ☺23
- Marketing green power ☺24
- Selling back to the grid ☺25

Major Learning Areas
(Completed activities)

Mathematics
Working Mathematically
Measurement
Chance & Data
Science
Investigating
Earth and Beyond
Life and Living
Society & Environment
ICP
Place and Space
Resources
Culture
Time, Continuity & Chance
Natural and Processes Systems
English
Conventions
Use of Texts
Processes and strategies
Listening
Speaking
Writing
Arts
Skills and Processes
Technology & Enterprise
Technology Process
Materials
Information

Overarching Learning Outcomes

1, 2, 3, 4, 5, 6, 7, 8, 10, 12, 13

Values

1. **Pursuit of knowledge and commitment to achievement of potential**
   1.1 The pursuit of personal excellence　1.2 Domains of human experience　1.3 Empowerment　1.4 Knowledge　1.5 Values systems　1.6 Critical reflection　1.7 World views
2. **Self acceptance and respect of self:**
   2.1. Individual uniqueness　2.2 Personal meaning　2.3 Ethical behaviour and responsibility　2.4 Openness to learning　2.5 Initiative and Enterprise
3. **Respect and concern for others and their rights**
   3.1. Compassion and care　3.3 Respect　3.4 Open Learning Environment　3.5 Individual Differences　3.6 Co-operation/conflict resolution　3.7 Family home environment
4. **Social and civic responsibility**
   4.1 Participation and citizenship　4.2 Community　4.3 Diversity　4.4 Contribution　4.7 Social justice　4.8 Responsibility and freedom　4.9 Benefit of research
5. **Environmental responsibility**
   5.1 Cultural heritage　5.2 Conservation of the environment　5.3 Sustainable development　5.4 Diversity of species

Multiple Intelligences

Bodily/Kinesthetic　Naturalistic　Verbal/Linguistic
Musical　Visual/Spatial　Intrapersonal
Logical/Mathematical　Interpersonal　Emotional

☺ Indicates an activity is attached

Integrated Learning Pathway Theme: Global Warming - Focus: Living in a Greenhouse

Focus Levels	1	2	3	4

OVERARCHING LEARNING OUTCOMES												
1	2	3	4	5	6	7	8	9	10	11	12	13

VALUES				
1	2	3	4	5

ENGLISH				SCIENCE					SOCIETY & ENVIRONMENT				
SL	V	R	W	IS	EB	EC	LL	NPM	ICP	PS	R	C	TCC

MATHEMATICS						T & E				HEALTH & PHYSICAL ED			
WM	S	M	CD	N	PAA	TP	M	I	S	KU	SPA	SmS	IS

THE ARTS			
AI	ASP	AR	AIS

LOTE		
LRS	VRR	W

OVERVIEW OF LEARNING OUTCOMES, OLOs and VALUES

Science I3.1 I3.2 I3.3 I3.4 EB3 EB4 EC3 EC4 LL3 LL4 NPM3 **English** LS3.1 LS4.1 LS3.2 LS3.3 LS3.4 LS4.4 LS4.3 V3.1 V3.2 V3.3 V3.4 W3.2 W3.3 W3.4 W4.1 W4.2 W4.3 W4.4 R3.1 R3.2 R3.3 R3.4 R4.1 **SOSE** ICP3.1 ICP3.2 ICP3.3 ICP3.4 R3.1 R3.2 R3.3 R4.1 NSS3.1 NSS3.2 NSS3.3 TCC3.2 TCC3.3 PS3.1 PS3.2 PS3.3 **Maths** WM3.3 WM5.3 N6a.3 N7.3 N8.3 C+D13a.3 C+D13b.3 C+D14.3 S15a.3 S15b.3 S16.3 M9a.3 M9b.3 M10a.3 M10b.3 M11.3 **H&PE** IPS3 KU3 **T&E** I3.1 I3.2 TP3.1 TP3.2 TP3.3 TP3.4 M3.1 S3.1 **The Arts** AR2 AIS2 AI2
OLOs 1 2 3 4 5 6 7 8 9 10 11 12 13 **Values** 1.1 1.5 1.6 1.7 2.1 2.3 2.4 3.2 3.3 3.5 3.6 4.1 4.2 4.4 4.8 5.1 5.2 5.3 5.4

Learning Experience 1 – Living in a Greenhouse

- **What is the Greenhouse Effect?** Brainstorm ideas and create a mind map *(diagnostic assessment)*
- **View "Saving Hieronymus"** Complete a structured overview. What are the 2 major problems with fossil fuels? How might the greenhouse effect change our climate? What types of human activities have increased CO_2 in the atmosphere? What solutions do you see?
- **Media Watch** Rotating groups research the extent and nature of issues linked to the greenhouse effect reported in the media. Categorise articles/programs, summarise main points, the main argument and whether you think it is justified. Develop a class summary using a spreadsheet to show the number and type of greenhouse topics reported in the media. Groups prepare a summary of how the media reports greenhouse issues. Create a graffiti board with the collected articles, editorial cartoons or headlines. Students discuss and explain their contributions.
- **View Greenhouse Effect web animation:** Draw a diagram and explain the atmosphere's role in keeping Earth's surface warm and controlling temperature.
- **Experiment - Measuring the greenhouse effect:** Create a greenhouse using a plastic bottle/terrarium; measure temperature inside and out, recorded every 5 mins for one hour using a table. Use graph paper to draw a line graph to illustrate and explain why the temperature might be different. How does this relate to what happens in our atmosphere? *(assessment)*
- **Mini Field Trip:** visit local greenhouse, measure and record temperature differences inside and out. Investigate types of plants.
- **Weather watchers:** Groups observe, record and discuss weather conditions daily and make simple inferences based their observations. Check findings against weather predictions in the media. Data to be displayed in tables and graphs using spreadsheets. Research average temperature/rainfall for the last 100 years, make a graph of temperature on 1 January of each year. Which decade was the hottest recorded? Discuss any trends or patterns observed.
- **Create a poem** "Living in a greenhouse" from the perspective of an insect or plant, depicting how life will be different if greenhouse gases continue to increase.
- **Web of Life role play:** Interrelationships - every plant and every animal is related to every other living and nonliving thing on the Earth. Energy from the sun provides fuel for all life. If one part of the web is broken or damaged it will affect other parts.

Learning Outcomes **Science** I3.1 I3.2 I3.3 I3.4 EB3 EB4 EC3 EC4 LL3 LL4 **English** V3.1 V3.2 V3.3 V3.4 LS4.1 LS4.3 R3.1 R3.2 R3.3 W3.3 W4.3 **SOSE** ICP3.2 ICP3.3 ICP3.4 R3.1 R4.1 R3.2 NSS3.1 **Maths** WM3.3 WM5.3 N6a.3 N8.3 M9a.3 M9b.3 C+D13a.3 C+D13b.3 C+D14.3 **H&PE** IPS3 **T&E** I3.1 I3.2 **OLOs** 1 2 3 4 5 7 10 12 13 **Values** 1.1 1.6 1.7 2.4 3.6 4.4 4.8 5.2 5.3 5.4

Learning Experience 2 – Who's Responsible? CO_2 and Me

- **Inquiry - What are renewable sources of energy?** Groups of 3 choose 3 renewable energy sources (solar, hydro, etc) to research. Create a report, brochure or Pp explaining 1. What the source is. 2. How it generates power. 3. Main advantages and disadvantages 4. How it will benefit the environment. 5. Your recommendations *(assessment)*
- **Atmosphere revision**: draw, label and describe layers. Describe temperature changes as you move away from the Earth's surface. What are the major gases found in the atmosphere? View carbon cycle animation and explore where carbon is stored in the biosphere and how the level of CO_2 in the atmosphere can be changed.
- **Experiments - Carbon cycle round robin:** Enables students to explore processes that increase and decrease the amount of CO_2 in the atmosphere. These processes involve chemical reactions such as combustion, photosynthesis and respiration, as well as the physical reaction of CO_2 dissolving in water.
- **Carbon dioxide in the atmosphere**. Provide a table of CO_2 levels from 1800-2000. Create a (scatter) graph representing data. What is happening to CO_2 levels? Extrapolate the graph. Estimate CO_2 levels in 2010 and 2020. Play CO_2 card game.
- **Write a short story** about a carbon atom as it journeys around the biosphere, decide where you will start and end your journey.
- **Transport study:** *Journey to school*: complete a table showing how each student travelled to and from school the previous day. Estimate distances travelled. Calculate the % for each mode of transport and total distance. Create a concept map exploring the importance of using alternative modes of transport; describe advantages/disadvantages for each mode.
- **Reducing fuel consumption**. Read and discuss Reducing Fuel Consumption fact sheet. Use the Eco-driver's licence test on your parents. As a class compile the results to get overall figures of driving habits. Create a table and construct a bar graph. Using the Fuel Consumption Guide research your family's fuel consumption per km. Compile class results and using the information from the transport study, estimate the amount of CO_2 that is pumped into the atmosphere (1litre of fuel = 3kg CO_2). What are the alternatives? Write a note to your parents advising ways to reduce fuel consumption. Promote a "carpool" or "walking school bus" day. Collate ideas, publish in school newsletter.
- **Create a futures wheel** showing the impact of the greenhouse effect or cause and effect fish bone graphic organiser *(peer assessment)*.

Learning Outcomes **Science** I3.1 I3.2 I3.3 EB3 EC3 **English** LS3.1 LS4.1 LS3.3 V3.1 V3.2 W3.2 W3.3 W3.4 W4.2 W4.4 R3.1 R4.1 **SOSE** ICP3.1 ICP3.3 ICP3.3 ICP3.4 R3.1 R3.2 R3.3 NSS3.1 **Maths** WM3.3 M11.3 N6a.3 N7.3 N8.3 C+E13a.3 C+D13b.3 C+D14.3 **H&PE** IPS3 **T&E** I3.1 I3.2 **OLOs** 1 2 3 4 5 7 12 **Values** 1.1 1.7 2.3 3.3 4.4 5.2 5.3

Learning Experience 3 – Fossil Fuels: Exploring the energy sources we use

- **Excursion to Collie Mine and Collie Power Station**. Map geographical location and area served. How is coal mined, transported and used? Is power demand expected to increase? By how much? Consider the employees – what would happen if the mine closed down?
- **Map out the journey of a fossil fuel** from extraction point to your power point, list any environmental impacts you can see along its journey *(peer assessment)*
- **Investigate pros and cons** of using fossil fuels? What are the major forms of fossil fuels? How are fossil fuels formed? On a blank outline map mark where coal is found in Aust. Using an atlas mark the countries to which we export coal. How much coal do we use/export? How much time before supplies run out? *(assessment)*
- **Poem "Digging up the Dead"** what does it mean? (fossil fuels). Guest speaker to discuss Aboriginal perspectives and connections to the land. Create a dramatised re-enactment of the creation of a fossil fuel
- **Consensus 1-2-4 Values Advocacy** Each student writes a list of what they feel to be important issues, then in pairs students combine ideas, discuss and modify their list. Two groups join together to share ideas and the process is repeated. Each group prioritises their ideas and advocate their position. Students are encouraged to express opinions and listen to, and respect other student's points of view.
- **Appliance audit:** Make a list of all the appliances in your home. Cross out all the appliances you can do without. Put a question mark against those you could use less. Put a tick next to the essentials. Note which fossil fuels are needed as a source of energy for each appliance. **Conduct a survey** to determine the average level of energy usage in your home. What time of day does usage peak? Tally class results, create a bar graph, find mean and present results. Make a list of the services and utilities that supply your home, sort into subgroups. What are the environmental impacts of each of these services?
- **Modifying energy usage in the home**. Analyse data from the survey to create a plan to reduce energy usage. Investigate one area (eg kitchen, bathroom). Explore alternatives that can lead to a reduction in energy usage. Design a poster giving 5 tips about saving energy resources in the home. Consider: purpose, audience, message, logo *(self assessment)*. Students collate ideas to be published in the school newsletter.
- **School energy audit**: Observe energy use, record data, evaluate usage and cost to school. Count the number of lights and estimate how many hours/day they are used, check the globe wattage, then work out how many kilowatt hours the class/school uses in day/week/month. Calculate how much greenhouse gases your classroom creates from lights 1kWh = 1kg of CO_2. Work out how much energy you would be conserving if you changed to lower wattage light bulbs. Create a school map divided into areas and mark the location of all electrical items. Put forward a proposal to the Principal on effective ways to reduce energy consumption.
- **Debate**. Miners and power station employees vs environmental group. Put forward reasons for or against operating coal fired power stations. Justify your position.

Learning Outcomes **Science** EC3 EB3 **English** LS3.1 LS3.2 LS4.3 R4.1 R3.2 R3.3 R3.4 W3.2 W4.2 W3.3 W4.3 W3.4 **SOSE** ICP3.1 ICP3.2 ICP3.4 ICP3.3 NSS3.1 NSS3.3 R3.1 R3.2 R3.3 PS3.2 **Maths** WM3.3 N6a.3 N7.3 N8.3 C+D13a.3 C+D13b.3 C+D14.3 S15a.3 S15b.3 M10b.3 **H&PE** IPS3 **The Arts** AR2 AIS2 AI2 **OLOs** 1 2 3 5 7 8 9 11 12 13 **Values** 1.6 1.7 2.1 3.2 3.3 4.2 5.1 5.2 5.3

Learning Experience 4 – What can we learn from all of this?

- **Energy through the ages**. Survey grandparents about energy sources when they were younger and how they compare with the way we use energy today (entertainment, lighting, travelling). Collate survey data and discuss reasons for change in patterns in use? Create a timeline showing how various energy sources have been used for transport during the past 100 years. Examine the shortcomings and benefits of those sources.
- **Experiment - Greenhouse Effect and Surface Radiation** demonstrates the greenhouse effect and the effect of different surfaces on light reflection. Individually test 2 beakers for the greenhouse effect and as a class, compare surfaces. Predict which substance will have the highest/lowest temperatures. Take readings of the temperatures for 30 minutes. Graph results. Report highest readings for both beakers and the difference between them. Explain why you think your readings varied.
- **Visit a low energy or autonomous house**. Take compasses to check its orientation. Sketch floor plan, noting position of all rooms. Sketch a section of the north wall to indicate how windows are shaded from the sun in summer, but not in winter. Show how trees and shrubs are positioned.
- **Design a passive solar house**. Small group project. Note what characteristics need to be included in your house. Is such a house possible? Prepare a short talk about the features of your house *(peer assessment)*
- **De Bono Six Thinking Hats Round Table**. Question: A law is to be introduced directing that all households must be carbon neutral. Throw 6 hats die, take turns making a statement using the hat shown on the die. Extends ways of thinking about a topic and enhances understanding. Students reflect on their thinking and recognise there are different ways of thinking and generating ideas.
- **"Look Up" (Toni Colette) song lyrics**. In a group of 3 one comments on the words only, one on the impact of the words with music, and one comments on matching of words, music and images evoked. Why is this considered persuasive text, author's devices, emotive language. Artistic reflection activity.

Specific Learning Outcomes **Science** I3.2 I3.3 EB3 EC3 NPM3 **English** LS3.1 LS4.1 LS3.4 LS4.4 W4.2 R4.1 R4.2 R4.3 **SOSE** R3.1 R3.2 NSS3.3 TCC3.2 TCC3.3 PS3.1 PS3.2 PS3.3 **Maths** WM3.3 N7.3 S15a.3 S15b.3 S16.3 M9a.3 M9b.3 M10a.3 M10b.3 M11.3 **T&E** TP3.1 TP3.2 TP3.3 TP3.4 M3.1 S3.1 **The Arts** AR2 AIS2 AI2 **HAPE** IPS3 **OLOs** 1 2 3 4 5 6 7 10 11 12 13 **Values** 1.5 3.5 3.6 4.1 4.2 5.2 5.3

Learning Experience 5 – Our World : Our Future

- **Global warming predicting future trends**. CSIRO has made a series of predictions about changing climate in Australia by 2030. What changes are likely to occur in our area? Make a list of the major impacts of climate change in Australia. The greenhouse effect will affect people and wildlife in different ways. Create a table, consider different groups, possible changes and reasons for change. How does this relate to Saving Hieronymus?
- **Plan a public education campaign** to try to change people's attitudes to energy use. Create a logo and advertisement for the school newsletter and local newspaper. Use framework for writing persuasive and informational texts.
- **Raising community awareness**. organise a community information session and PowerPoint presentation on greenhouse emissions and what individuals and governments can do to make a difference. Invite community members, local members of parliament and newspaper journalists to come to your school to hear your concerns *(summative assessment)*
- **Crystal Ball activity**. Students draw their understandings to predict or speculate about what they think the future will hold for the insects and plants in their poems writing during Experience 1. Students are encouraged to discuss and give good reason for their thinking, which helps to clarify their understandings.
- **Reflective Writing**. What have I learnt about the future of our planet? How will I use this knowledge in my life? Where to now? *(self assessment)*
- **Time Capsule**. collect energy related items for burial in a time capsule. Gather information about energy today and predictions for the future. Add grandparent survey data, timeline and copies of relevant newspaper articles.
- **Quiz: The Energy Challenge** test student's knowledge *(summative assessment)*

Learning Outcomes **Science** EC3 EB3 **English** LS3.1 LS3.2 LS4.4 R3.1 R3.2 R3.3 W3.2 W3.3 W3.4 W4.2 W4.3 **SOSE** ICP3.1 ICP3.2 ICP3.4 ICP3.3 NSS3.1 NSS3.2 NSS3.3 R3.1 R3.2 R3.3 PS3.2 **Maths** WM3.3 N6a.3 N7.3 N8.3 C+D13a.3 C+D13b.3 C+D14.3 **H&PE** IPS3 **OLOs** 1 2 3 4 5 7 9 11 12 13 **Values** 1.6 1.7 2.1 3.2 3.3 4.2 5.1 5.2 5.3

Overview of Learning Area Unit Plans

	Society and Environment	Science	Mathematics	English
	Energy Conservation	Energy and Change	Measurement applied	Persuasive Texts
	Power for the people	Hydroelectric Power Generation	Hydro Power Maths	Marketing Renewable Power
Engage	Pemberton power	Powerful water.	Measurement	Powerful Words
	• Historical overview of hydroelectric energy in Pemberton	• The water cycle • Hydro Power - what we think we know	• Volume and Capacity - what we think we know • Estimating • Volumes of rectangular prisms	• Making an argument • Emotive text
Explore	Energy audit	Turbines to turn. Inductance.	Measurement and Space	Opinion and Fact
	• Energy use • Ecological footprint • Global warming • Simulations	• Getting a Reaction • Acting on Impulse • Far out Faraday!	• How big is a cubic Metre? • Estimating and Direct Measure - classroom capacity • Areas of dams • Linking cm^3, m^3, mLs and Litres	• Text types (narrative, editorials, letters, articles, images and film)
Explain	The power grid	Turbine and Generator A Powerful Pair	Number and Measurement Comparisons and Calculations	Persuasion is…
	• Energy sources • Distribution of power plants in Western Australia • Mapping	• Review of Explore activities • Scientific terminology • The parts of a commercial hydroelectric turbine	• Units and prefixes • Capacity calculations • Comparison of classroom capacity to Pemberton and other dams	• Language features • Argumentative texts
Elaborate	Town Planning	Go with the flow.	Graphing and Interpreting	Marketing Renewable Energy
	• Meeting energy needs • Town planning	• Investigation of flow rates of water from dams	• Catchment rainfall • Stream flow rates • Pipe flow rates v diameter	• Selling the concept
Evaluate	Power Play	Falling and Rising. The energy and power of water	Connecting it all together	Convince Me!
	• Energy Conservation	• Labelled and annotated conceptual flow diagram of a hydroelectric power station.	• Applying the mathematics to a Hydroelectric scenario	• Presenting the marketing plans • Storyboard

Science Curriculum Materials

Science Unit Plan	
Outcomes: Energy and Change Investigating	Title: The Power of Water
Key concepts/conceptual understandings	
Hydroelectric power generation	
Overview of key concepts	
Electrical energy is an integral part of our everyday lives. Energy is drawn from non-renewable resources such as coal, oil and other fossil fuels as well as from renewable resources including solar, wind and water. Depending on the source, there are a variety of ways that energy is transferred and transformed which enable us to have ready access to it in the form of electricity. This series of lessons allows students to develop a deeper understanding of the scientific concepts associated with hydroelectric power generation. Through hands-on activities, students explore the ways that the potential energy in stored water can be transferred to produce rotational kinetic energy and look at the role that magnetism plays in transforming rotational kinetic energy into electrical energy. By investigating water flow rates, students explain how gravitational potential energy can be utilised effectively. They consider factors affecting the efficient transfer of energy and describe the process of hydroelectric power generation and the types of energy associated with it.	

Science Unit Outcomes – Level 3,4 and 5 (*WA Outcomes and Standards Framework)*		
Level 3	**Level 4**	**Level 5**
Energy and Change Students classify objects as sources or receivers of energy. Students begin to use terms such as kinetic energy to identify energy of movement. Students understand some types of energy transfers and changes (transformations) and can represent them in flow diagrams. **Investigating** The student shows some awareness of the need for fair testing and makes simple predictions; collects and organises numerical data and descriptive information using simple tables, diagrams and graphs; and identifies main features, patterns and difficulties in the investigation.	**Energy and Change** Students can explain how forces can affect movement. They understand how potential energy can be transformed into kinetic energy. Students relate the transformation of energy to intended uses of the energy. They begin to describe the size of a force using standard units of measurement and explain how forces and energy transformations are involved in the operation of a range of machines. **Investigating** The student plans and conducts different types of investigations, taking account of the main variables; collects data using repeat trials; explains patterns in data; and makes general suggestions for improving the investigation.	**Energy and Change** Students differentiate between input and output energies, sources and receivers and can analyse energy converters in these terms. They understand that energy can be stored in water in a dam. Students understand and represent the transfer and transformation of energy using models or conceptual flow diagrams. Students explain the conversion of energy into other forms and the effects of that conversion. Students use the concepts of power and efficiency to explain physical situations of energy transfer and transformation. **Investigating** The student interprets a situation to formulate a plausible relationship to investigate using experimental techniques, including the control of several variables and the use of preliminary trials; develops scientific explanations that are consistent with the data; and makes specific suggestions for improving the investigation.
Note: Although some Earth and Beyond outcomes can also be addressed through these lessons, the level 4 and 5 Energy and Change outcomes and the level 4 Investigating outcomes are intended to be the main focus. During the Elaborate phase, students expecting to demonstrate level 3 Investigating outcomes can be given the question for investigation and a structured results table to help them develop level 4 Investigating skills. Depending on available equipment and resources, there is also scope for teachers to allow for level 5 Investigating outcomes to be demonstrated.		

ENGAGE **(1-2 lessons)**	▪ *To capture students' interest and find out what they think they know about hydroelectric power generation.* ▪ *To elicit students' questions about how hydroelectric power is generated.*
Lesson number 1	Lesson title: Powerful water

AT A GLANCE

Students will:

- observe the powerful effects of water on the Earth and reflect on the energy it contains;
- recall instances, with an emphasis on personal experience, where they have seen the damaging effects of water or the energy in water being harnessed. Through "think, pair, share", they discuss their views;
- draw a diagram of the water cycle;
- demonstrate what they think they know about hydroelectric power generation by constructing a labelled flow diagram of the elements of a hydroelectric power station;

Assessment - Diagnostic	In this lesson you will find out what students already know about the water cycle and hydroelectric power generation. This will allow you to take account of students' existing ideas when planning learning experiences.
	Assessment task/s Labelled and annotate diagram of the water cycle; Cut and paste - construct a flow diagram of the elements of a hydroelectric power station. Label and annotate as appropriate.

Literacy focuses	
Science journal	
Labelled diagrams	

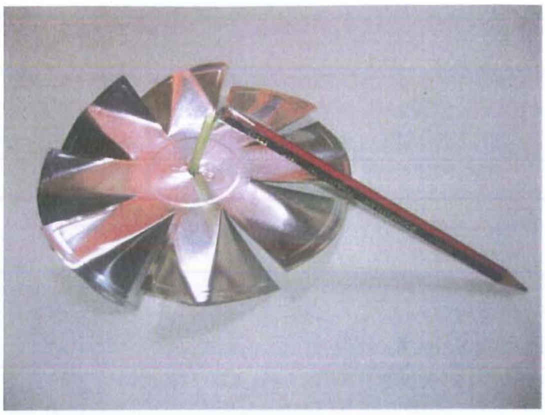
<table>
<tr><td rowspan="1">EXPLORE
(2-3 lessons)</td><td colspan="2">

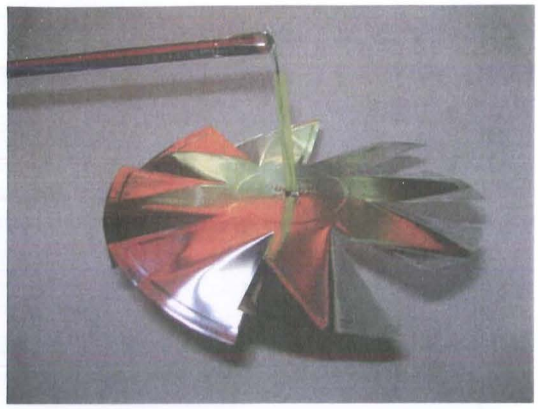
- *To provide hands on, shared experiences of the operation of model turbines.*
- *To support students to investigate and explore ideas about the size and direction of forces involving water and the way they affect the motion and power of the turbines.*
- *To provide hands on, shared experiences of inductance and the operation of an electric generator.*
- *To support students to investigate and explore ideas about electromagnetic inductance and its relationship to the construction and operation of an electric generator.*

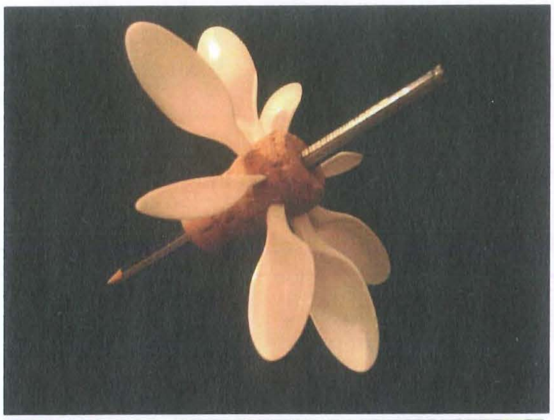
</td></tr>
<tr><td colspan="2">Lesson number 2, 3 and 4</td><td>Lesson titles:
Turbines to turn - Getting a Reaction
Turbines to turn - Acting on Impulse
Far out Faraday!</td></tr>
<tr><td colspan="3">AT A GLANCE</td></tr>
<tr><td colspan="3">Students will:

- work in cooperative learning teams to build a simple reaction turbine (Kaplan style) and operate it with water;
- work in cooperative learning teams to construct a simple impulse turbine (Pelton style), operate it with water and investigate the effect water flow rate has on the rotation of the shaft;
- draw force arrow diagrams of the model turbines in motion;
- observe and record information about the working of different toys and tools that use motion to generate electrical power;
- read and discuss a description of the 1831 experiment performed by Michael Faraday that led to his discovery of electromagnetic inductance;
- work in small groups to construct and operate a simple electrical generator or observe a demonstration of a generator being operated to produce electrical energy.

</td></tr>
<tr><td colspan="3">Literacy focuses</td></tr>
<tr><td colspan="2"></td><td></td></tr>
<tr><td colspan="2"></td><td></td></tr>
</table>







EXPLAIN **(1 lesson)**	▪ *To support students to develop explanations for experiences and make representations of developing conceptual understanding about hydroelectric power generation.*

Lesson number 5	Lesson title: Turbine and Generator - A Powerful Pair

AT A GLANCE
Students will: • discuss findings of the activities from lessons 2, 3 and 4; • will become familiar with relevant scientific terminology - inductance, electromagnetism, potential energy, rotational kinetic energy and the components of turbines and generators; • cut and paste labels for a diagram of a commercial hydroelectric turbine based on a description of its operation.

Assessment – Formative	In this lesson you are looking for evidence that students are developing an understanding of the way hydropower turbines and generators operate and combine to produce electricity. You should also look for evidence of students' use of appropriate ways to represent what they know and understand about a hydroelectric turbine and give them feedback on how they can improve their representations.
	Assessment task/s Word loop activity Labelled diagram of a commercial hydroelectric turbine based on a description of its operation.

Literacy focuses	
Science journal	
Labelled diagram	

<table>
<tr><td>ELABORATE
Investigation
(1-2 lessons)</td><td colspan="2">▪ To challenge and extend students' understanding in a new context or make connections to additional concepts through a student planned investigation.
▪ To use investigative skills to study flow rates of water.</td></tr>
<tr><td colspan="2">Lesson numbers 6 and 7</td><td>Lesson titles:
Go with the flow - Part 1
Go with the flow - Part 2</td></tr>
<tr><td colspan="3">AT A GLANCE</td></tr>
<tr><td colspan="3">Students will:
• work in cooperative learning teams to construct a simple model of a reservoir and pipeline;
• use the model to investigate the factors that could affect the flow rate of water from a dam.

In lesson 6 the students plan and conduct the investigation
In lesson 7 they process their results and evaluate both their findings and the investigation itself</td></tr>
<tr><td rowspan="2">Assessment - Summative</td><td colspan="2">In this lesson you are looking for evidence about the extent to which students have achieved the Level 4 investigating outcomes. Students will be able to:
- develop their own question and make predictions about factors that could affect the flow rate of water from a dam;
- plan and conduct an investigation taking into account the main variables;
- collect data using repeat trials;
- calculate averages and plot data as a line graph where appropriate;
- identify and explain patterns in data;
- identify difficulties experienced during the investigation and make general suggestions for improvement.
Students expecting to demonstrate level 3 investigating outcomes can be given the question for investigation and a structured results table to help them develop level 4 skills.
Within the lesson as set out, level 5 processing data and evaluating outcomes can be demonstrated. Depending on available equipment and resources, there is scope for teachers to assess level 5 planning and conducting outcomes.</td></tr>
<tr><td colspan="2">Assessment task/s
Students use straws, blutac, 1 and 2 Litre plastic bottles/cartons, a stopwatch and water to investigate flow rates.</td></tr>
<tr><td colspan="3">Literacy focuses</td></tr>
<tr><td colspan="2"></td><td></td></tr>
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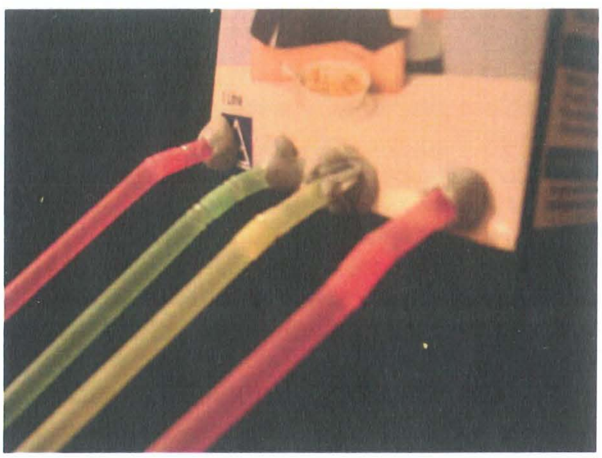
To a first approximation, different cross sectional areas can be achieved by varying the number of straws.



Students can investigate the effect on flow rates of

- changing angles,
- number of straws,
- vertical height above ground
- etc

EVALUATE **(1 lesson)**	▪ *To provide opportunities for students to review and reflect on their learning and to represent what they know about hydroelectric power generation and the associated energy transfers and transformations.*

Lesson number 8	Lesson title: Falling and Rising - The energy and power of water

AT A GLANCE

Students will:

- create a conceptual flow diagram incorporating the elements of a hydroelectric power station;
- label and annotate the diagram to demonstrate their knowledge and understanding of the flow of energy; this will detail the energy types, transfers and transformations involved.

Assessment – Summative	In this lesson you will be looking for evidence that students have achieved the Level 4 conceptual outcomes. Students will be able to: - explain how forces can affect movement; - Explain how potential energy can be transformed into kinetic energy; - relate the transformation of energy to intended uses of the energy. You will also be able to monitor progress towards the Level 5 conceptual outcomes. Students will be able to: - explain how energy can be stored in water in a dam; - outline and represent the transfer and transformation of energy using models or conceptual flow diagrams; - describe the conversion of energy into other forms and the effects of that conversion; - use the concepts of power and efficiency to explain physical situations of energy transfer and transformation.
	Assessment task/s Word loop activity. Cut and paste conceptual flow diagram incorporating the elements of a hydroelectric power station. Label and annotate to demonstrate knowledge and understanding of the flow of energy; detailing the energy types, transfers and transformations involved.

Literacy focuses

Lesson 1: Powerful water

AT A GLANCE

- To capture students' interest and find out what they think they know about hydroelectric power generation;
- To elicit students' questions about how hydroelectric power is generated.

Students will:

- observe the powerful effects of water on the Earth and reflect on the energy it contains;
- recall and discuss instances, with an emphasis on personal experience, where they have seen the damaging effects of water or the energy in water being harnessed;
- draw a diagram of the water cycle;
- demonstrate what they think they know about hydroelectric power generation by constructing a labelled schematic diagram.

Assessment focus - Diagnostic

In this lesson you will find out what students already know about the water cycle and hydroelectric power generation. This will allow you to take account of students' existing ideas when planning learning experiences.

Key lesson outcomes for Science

Students will be able to

- discuss and record their observations about the powerful effects of water;
- discuss how the energy in water can be harnessed;
- draw a diagram of the water cycle;
- explain what they know about hydroelectric power generation by constructing a labelled schematic diagram.

Equipment

FOR THE CLASS

- water station with pumps / waterwheels / water actuated toys to demonstrate various water based actions. Sand/soil to show erosion;
- appropriate video footage and still photos of tsunamis, floods, mudslides and erosion that illustrate the power exerted by water.

FOR EACH STUDENT

- each students' science journal;
- 1 A3 copy of 'Elements of a hydroelectric power station';
- 1 A3 copy of 'Hydroelectric power station schematic diagram' background.

Preparation

- Set up water station;
- Organise TV/DVD player;
- Optional; set up display area on wall of classroom to record key words, student's questions and pictures that relate to the unit as it progresses. Headings could be provided to help keep sections organised (including one titled 'Eureka!' to record significant moments in student learning).

Big Brook Dam Pemberton

Lesson steps

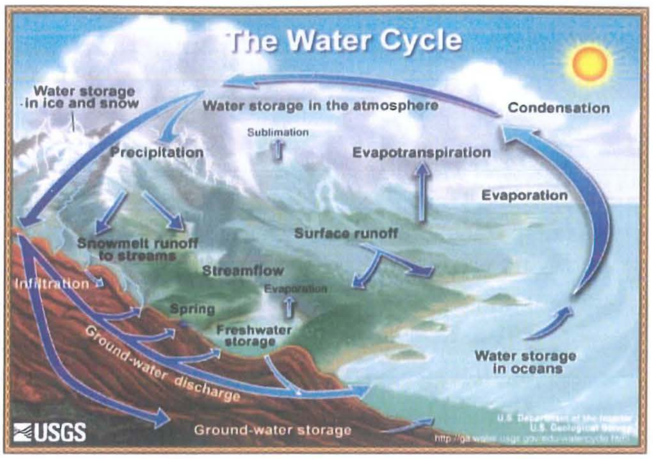
1. Introduce the water station and associated equipment and materials.
2. Explain that students will be observing the actions and impacts of water through the water station demonstrations and by viewing photographs and a video of events that have been influenced by water.
3. Demonstrate the various interactions between water and the equipment and materials. Call on students to assist in conducting the demonstrations where possible.
4. If students aren't familiar with the use of a science journal, discuss the purpose and features with them. Let them know that the journal is for them to date and record their observations, experiences and reflective thoughts and can include photographs, drawings, tables and graphs.
5. Direct students participation in a 'think, pair, share' strategy. The aim of this part of the lesson is to have them relate personally to the power that can be exerted by water. Initially, ask students to record their own thoughts in their science journals. Consider prompting them by asking, for example, "Have you ever waded across a creek/ got caught in a rip/ been in waves at the beach/ been caught in flooding/ stood under a waterfall? What did you feel?"
6. After a few minutes, encourage students to share their experience with their partner. Then open it up into a full class discussion - relate their experiences to the transfer of energy from water to the movement they felt.

   Organise students to view video and photographs. Having viewed video and photographs, facilitate a whole class discussion about the damaging effects of water. Steer discussion around to ideas of how the energy in water might be accessed to benefit people. Allow suggestions to come up that may include wave, tidal and hydro power.

Lefroy Brook Weir

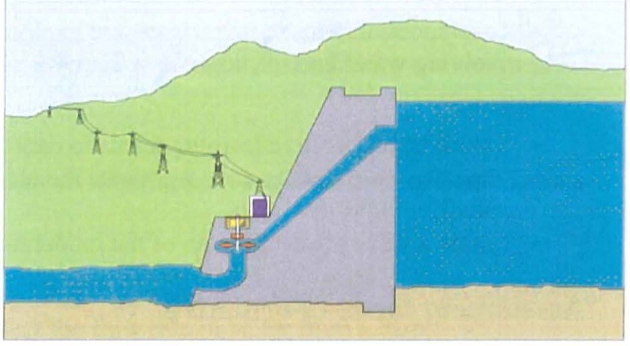
It is important in the Engage phase to allow for students to respond and contribute without correcting or providing them with formal definitions. This is an opportunity to gain an insight into students thinking and prior knowledge and to diagnose alternative conceptions and plan accordingly.

7 Ask students to draw a diagram of the water cycle in their science journals. In groups ask them to discuss where the energy comes from that drives the cycle. Direct the students to record the ideas of their group in their science journals. The water cycle will be reviewed in lesson 2.



8 Advise students that, over the coming lessons, they will be learning about hydroelectric power generation. Let them know that it is important to find out what they think they already know about it. Inform them that they will be given a worksheet with pictures of parts of a hydroelectric power station. They are to cut them out and glue them into an appropriate sequence on the A3 background sheet 'Hydroelectric power station schematic diagram'. Ask them to add labels, arrows and explanatory notes to the schematic diagram to help explain what they know. The completed A3 page will be glued into their journals.

9 Organise students so that they can work individually. Distribute the A3 copies of the 'Elements of a hydroelectric power station' and the 'Hydroelectric power station schematic diagram' background. Read through the accompanying instructions with the students and direct them to begin. The elements given to students are the dam, penstock, turbine, generator, transformer and transmission lines. These terms will be covered in detail during the *Explain* phase in lesson 5.



At this stage it would be necessary to consider how much guidance and prompting would be appropriate for the students. They may want to express their knowledge and understanding in relation to a simple component circuit or water flow route or to something more complicated that refers to energy types, flows, transfers and transformations. Consider noting assistance that is given.

10 On completion of the activity, collect up the science journals for review.

Lesson 2: Turbines to turn - Getting a Reaction

AT A GLANCE

- To provide hands on, shared experiences of the operation of a model turbine.
- To support students to investigate and explore ideas about the size and direction of forces involving water and the way they affect the motion and power of the turbine.

Students will:

- work in cooperative learning teams to build a simple reaction turbine (Kaplan style) and operate it with water;
- draw a force arrow diagram of the model turbine in motion.

Assessment focus – Formative

Lesson 3: Turbines to turn - Acting on Impulse

AT A GLANCE

- To provide hands on, shared experiences of the operation of a model turbine.
- To support students to investigate and explore ideas about the size and direction of forces involving water and the way they affect the motion and power of the turbine.

Students will:

- work in cooperative learning teams to construct a simple impulse turbine (Pelton style), operate it with water and investigate the effect water flow rate has on the rotation of the shaft;
- draw a force arrow diagram of the model turbine in motion.

Assessment focus - Formative

Lesson 4: Far out Faraday!

AT A GLANCE

- To provide hands on, shared experiences of inductance and the operation of an electric generator.
- To support students to investigate and explore ideas about electromagnetic inductance and its relationship to the construction and operation of an electric generator.

Students will:

- observe and record information about the working of different toys and tools that use motion to generate electrical power;
- read and discuss a description of the 1831 experiment performed by Michael Faraday that led to his discovery of electromagnetic inductance;
- work in small groups to construct and operate a simple electrical generator or observe a demonstration of a generator being operated to produce electrical energy.

Assessment focus - Formative

Lesson 5: Turbine and Generator - A Powerful Pair

AT A GLANCE

- To support students to develop explanations for experiences and support students to represent and describe their developing conceptual understanding of hydroelectric power generation.

Students will:

- discuss findings of the activities from lessons 2, 3 and 4;
- be introduced to relevant scientific terminology - energy transfers and transformations, flow rates, lines of magnetic force, inductance, electromagnetism, potential energy, rotational kinetic energy and the components of turbines and generators;
- cut and paste labels for a diagram of a commercial hydroelectric turbine based on a description of its operation.

Assessment focus - Formative

In this lesson you are looking for evidence that students are developing an understanding of the way hydropower turbines and generators operate and combine to produce electricity.
You should also look for evidence of students' use of appropriate ways to represent what they know and understand about a hydroelectric turbine and give them feedback on how they can improve their representations.

Lesson 6: Go with the flow - Part 1

AT A GLANCE

- To support students' to plan and conduct an investigation into flow rates of water from a dam.

Students will:

- work in cooperative learning teams;
- identify the variables that could affect the flow rate of water from a dam;
- formulate a question for investigation;
- construct a simple model of a reservoir and pipeline;
- use the model to conduct an investigation and collect data.

Assessment focus

In lessons 6 and 7 you are looking for evidence about the extent to which students have achieved the Level 4 investigating outcomes:

Students will be able to

- develop their own question and make predictions about factors that could affect the flow rate of water from a dam;
- plan and conduct an investigation taking into account the main variables;
- collect data using repeat trials;
- calculate averages and plot data as a line graph where appropriate;
- identify and explain patterns in data;
- identify difficulties experienced during the investigation and make general suggestions for improvement.

Students expecting to demonstrate level 3 investigating outcomes can be given the question for investigation and a structured results table to help them develop level 4 skills. Within the lesson as set out, level 5 processing data and evaluating outcomes can be demonstrated. Depending on available equipment and resources, there is scope for teachers to assess level 5 planning and conducting outcomes.

Lesson 7: Go with the flow - Part 2

AT A GLANCE

- To support students' to process and evaluate an investigation into flow rates of water from a dam.

Students will:

- process the results of the investigation conducted in lesson 6;
- explain their results and evaluate the investigation ;
- share results and discuss the evaluations they have made.

Assessment focus - Summative

See Lesson 6 for details about assessment for this lesson.
In particular the Level 4 investigating outcomes applicable to this lesson are:

Students will be able to

- calculate averages and plot data as a line graph where appropriate;
- identify and explain patterns in data ;
- identify difficulties experienced during the investigation and make general suggestions for improvement.

Lesson 8: Falling and Rising - The energy and power of water

AT A GLANCE

- To provide opportunities for students to review and reflect on their learning and to represent what they know about hydroelectric power generation and the associated energy transfers and transformations.

Students will:

- Create a conceptual flow diagram incorporating the elements of a hydroelectric power station;
- Label and annotate the diagram to demonstrate their knowledge and understanding of the flow of energy. This will detail the energy types, transfers and transformations involved.

Assessment focus -Summative

In this lesson you will be looking for evidence that students have achieved the Level 4 conceptual outcomes:

Students will be able to:

- explain how forces can affect movement;
- understand how potential energy can be transformed into kinetic energy;
- relate the transformation of energy to intended uses of the energy.

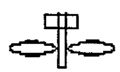
You will also be able to monitor progress towards the Level 5 conceptual outcomes:

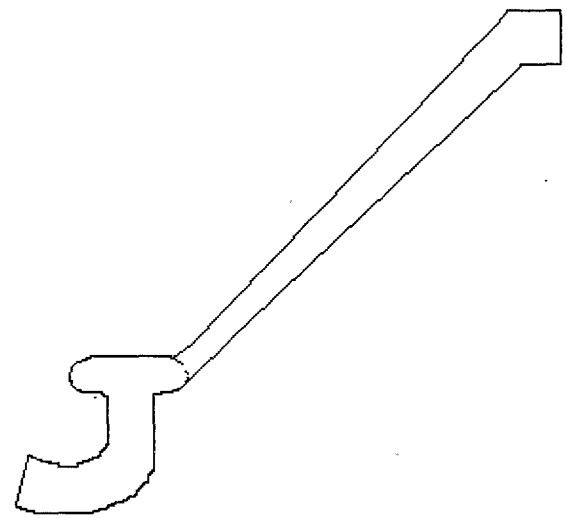
Students will be able to:

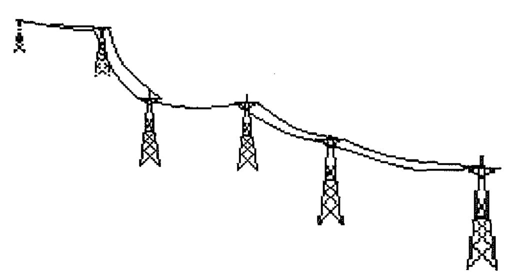
- explain how energy can be stored in water in a dam;
- represent the transfer and transformation of energy using models or conceptual flow diagrams;
- explain the conversion of energy into other forms and the effects of that conversion;
- use the concepts of power and efficiency to explain physical situations of energy transfer and transformation.

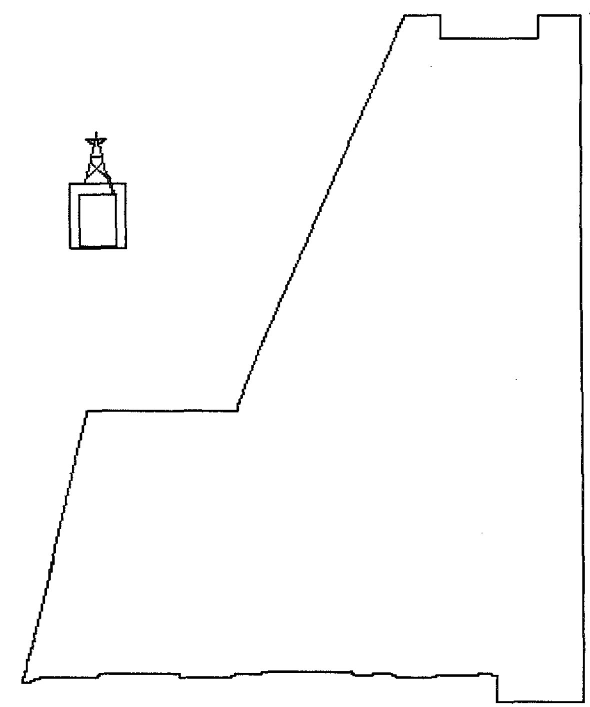
Elements of a hydroelectric power station

Cut out each of the six parts and glue them to the background page. You need to add the water; indicate the water in your diagram by colouring it in.



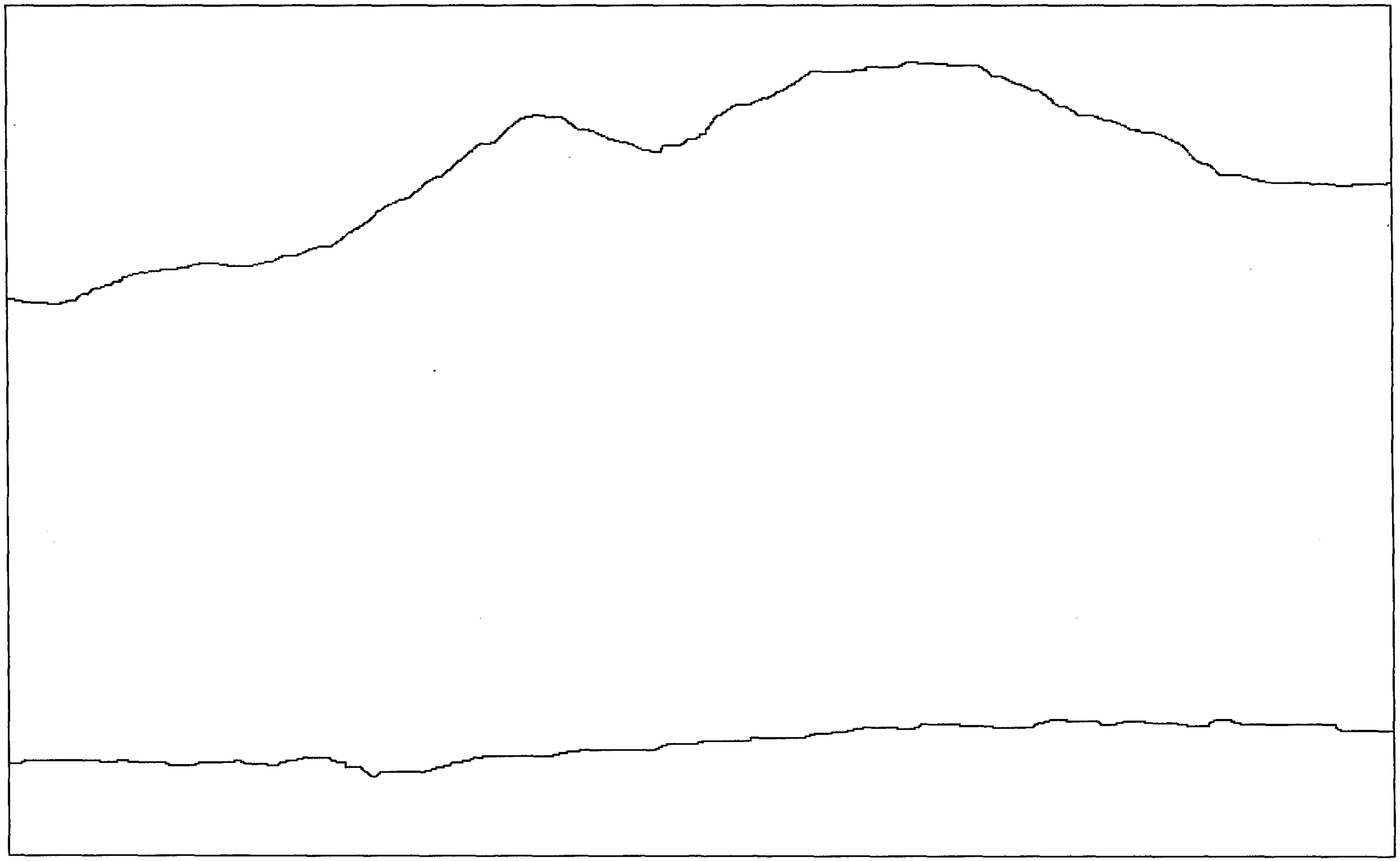


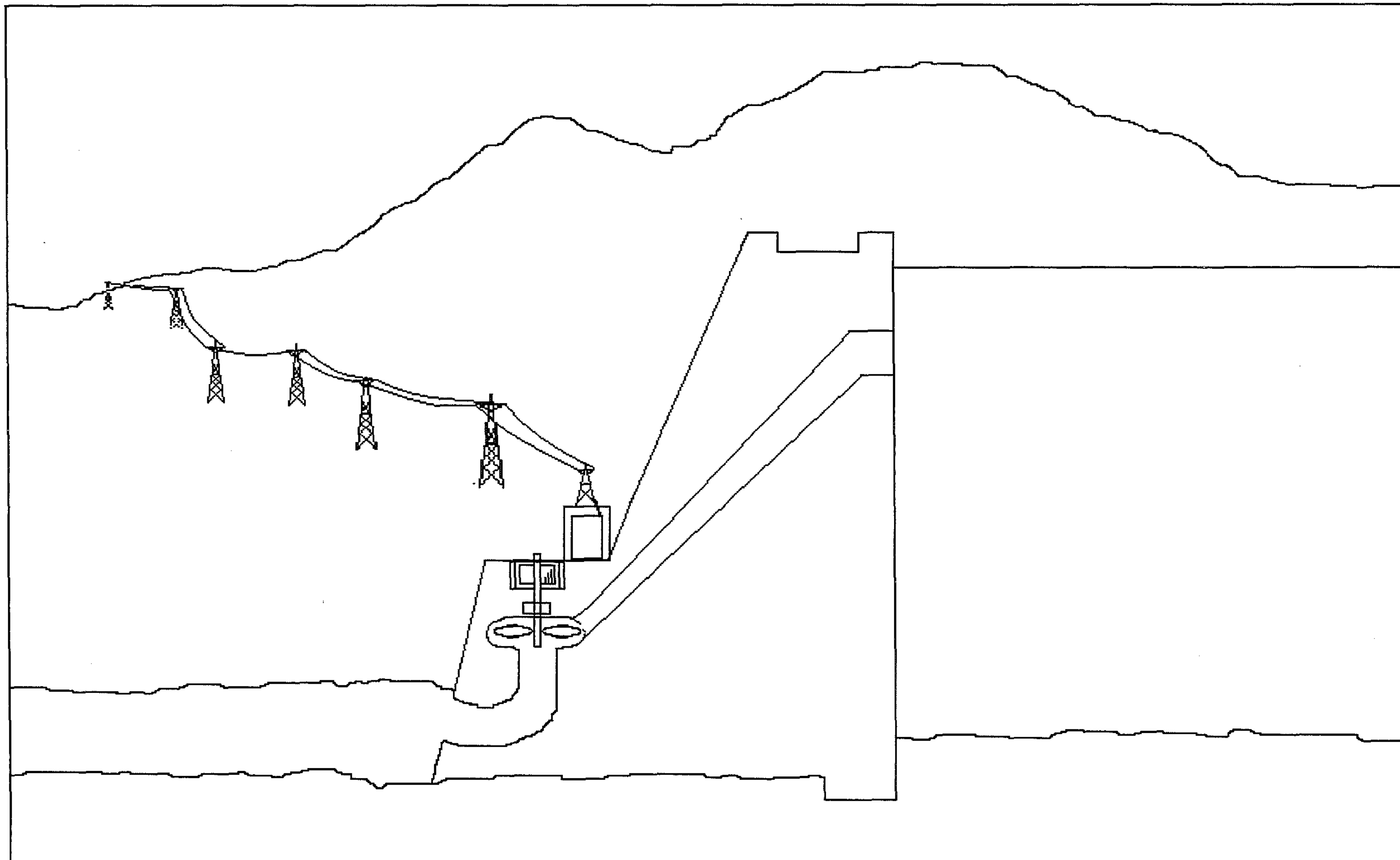


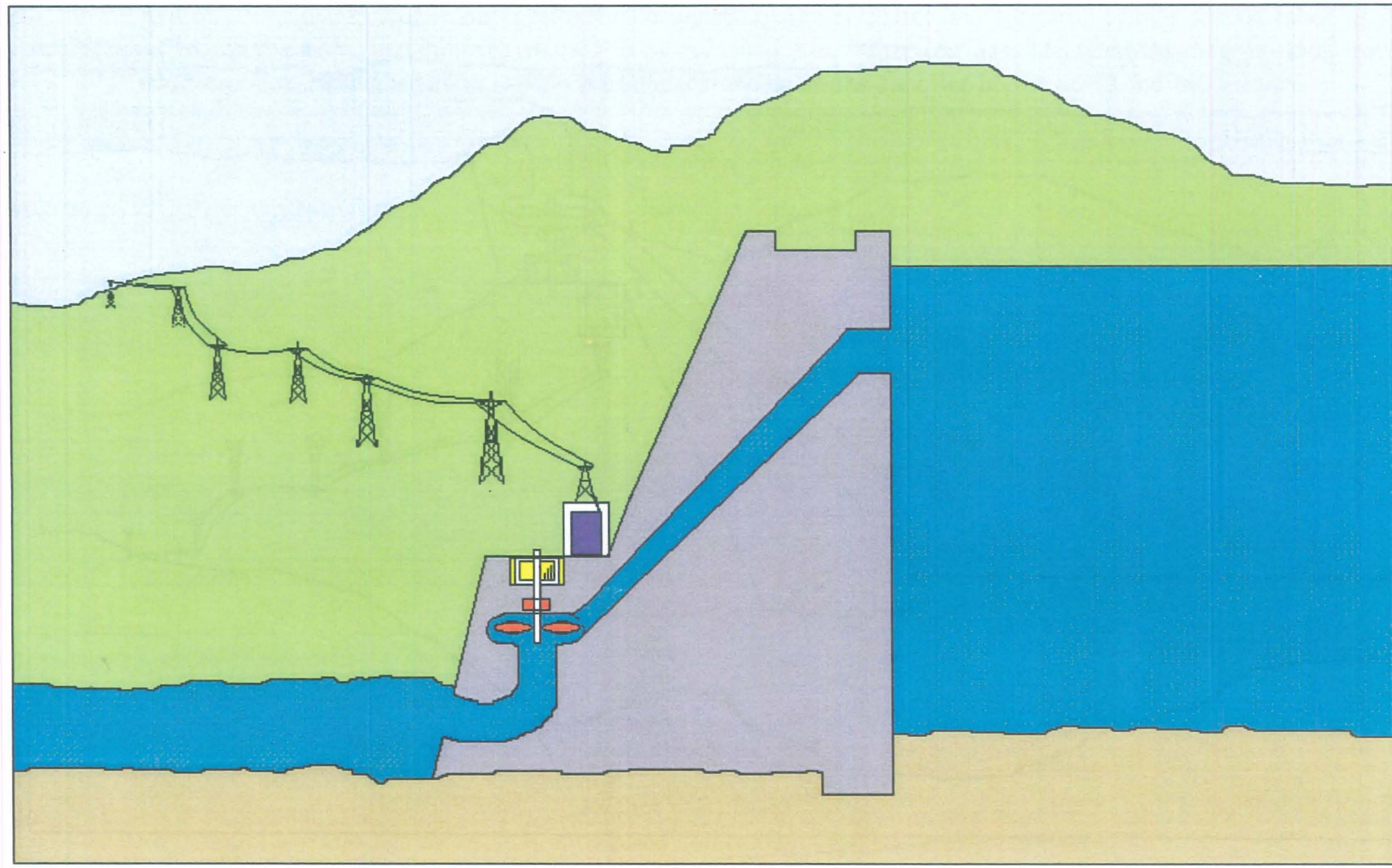


<u>Hydroelectric power station schematic diagram</u>

Glue the six hydroelectric power station parts onto the background. The river bed and backdrop of hills are sketched for you - don't forget to add the water and indicate where it is by colouring it in. Wherever possible, label the diagram and provide additional descriptive notes to explain your understanding of the function of the parts and the station.







Mathematics Curriculum Materials

Mathematics Unit Plan	
Outcomes: Measurement, Number and Space	Title: The Power of Water

Key concepts/conceptual understandings

To introduce students to some of the mathematics associated with hydroelectric power generation.

Overview of key concepts

Water is one of the major renewable energy resources in use around the world today. Hydroelectric power generation provides for a range of electricity requirements, from the small scale needs of individual households through to large scale systems that supply the electrical energy for entire countries.

This series of lessons allow students to develop a deeper understanding of the measurement attributes of area, volume and capacity. Through hands on activities, students investigate volumes of rectangular prisms and equate standard units of capacity with those of volume. Students process data to construct and interpret graphs, estimate large volumes and interpret scale drawings to determine areas of catchments and reservoirs. They use rainfall data to calculate volumes of water received by a catchment and compare this to stream flow rates in the catchment.

Applying mathematics to solve or understand "real world" problems and situations provides a sense of purpose which, for many students, is a strong motivating factor in their learning. Concrete experiences allow students to get a 'feel' for the standard units of cubic metres and Litres as well as the quantities associated with large numbers. By also learning about metric prefixes, students are able to relate to the magnitude of the large volumes of water involved in hydropower generation.

The unit culminates in a summative assessment opportunity in which students are provided with a scenario involving elements of a hydropower station. By analysing the situation and applying their mathematical skills and understanding students are able to demonstrate their achievement of level 4 outcomes.

<table>
<tr><th colspan="3">Mathematics Unit Outcomes – Level 3, 4 and 5 (WA Outcomes and Standards Framework)</th></tr>
<tr><th>Level 3</th><th>Level 4</th><th>Level 5</th></tr>
<tr><td>Measurement
The student realises that using a uniform unit repeatedly to match an object gives a measure of the size of the object and chooses suitable and uniform things to use as units and a common unit to compare two things.
The student understands the significance of measuring accurately and why gaps and overlaps should be avoided and also tries to take into account part units.
The student makes sensible numerical estimates using units that can be seen or handled.

Chance and Data
Students understand that the lengths in bar graphs can be used to represent measurements made at equal intervals over a period of time.
Students interpret tables and bar graphs produced by themselves and others and draw sensible conclusions.
Students explain what their displays show.

Space
The student understands a map or plan as a 'bird's eye view', (and able to place and locate key features in a plan but may not attend to scale or the overall frame of reference in it).
Students understand the features of 3D shapes in solid, hollow and skeletal forms.
Students imagine or draw different cross-sections of simple 3D shapes.
Students understand the difference between a prism and a pyramid.</td>
<td>Measurement
The student understands the unit as a quantity and expresses measures of length and capacity using common metric prefixes and appropriate notation.
The student selects appropriate attributes, distinguishes area from volume and chooses units of a sensible size for the descriptions and comparisons to be made.
The student measures area by counting uniform units, including part units where required, volume by counting cubes and capacity by reading whole-number scales.
The student understands the area of regions based on squares and the volume of prisms based on cubes, and uses these for practical purposes.
The student uses the known size of familiar things to help make and improve estimates.

Chance and Data
Students display data in bar graphs where the axis is labelled with discrete categories.
Students produce a graph using the vertical scale to help them plot data points, given a horizontal axis showing the progression of time.
Students read the information provided on axes of bar and line graphs.
Students interpret and report on information provided in line graphs, describing trends in data informally.

Space
Students understand and use grids and whole number scales, such as one centimetre for each metre, to interpret and make maps.
Students understand some of the more common conventions for drawing 3D shapes.</td>
<td>Measurement
The student is confident in the use of metric units and in the prefixes of these units and can convert from one unit to another when required or practical.
The student understands and applies directly length, area and volume relationships for shapes based on rectangles and rectangular prisms.
The student understands and uses scale factors.
Students make sensible estimates from their memory of common standard units and by comparison with the known size of things and develop strategies to estimate measurements.

Chance and Data
Students sort data using a calculator or computer to compare groups and use appropriate graphs to represent such data (generating some graphs with the assistance of a graphic calculator or computer).
Students use fractions and percentages to describe and compare their results.
Students use a range of graphs such as line plots for bivariate data, bar graphs and compound column graphs.
Students interpret a variety of graphs where the scales on the axes must be read between calibrations.
Students are able to extract information from tables and graphs showing the relationship between two quantities.
Students can present reports on the information displayed in a range of tables and graphs.</td></tr>
<tr><td colspan="3">Note: Although some Number and Space outcomes can also be addressed through these lessons, the level 4 and 5 Measurement outcomes and the level 4 Chance and Data outcomes are intended to be the main focus.
Details of outcomes outside the focus of these lessons, which still have relevance, are also included to provide a broad overview and to assist with 'where students are at'.</td></tr>
</table>

<table>
<tr><td>ENGAGE
(1-2 lessons)</td><td colspan="2">▪ To capture students' interest and find out what they think they know about volume and capacity.
▪ To elicit students' questions about volume and capacity.</td></tr>
<tr><td colspan="2">Lesson number 1</td><td>Lesson title:
Cubic combinations</td></tr>
<tr><td colspan="3">AT A GLANCE</td></tr>
<tr><td colspan="3">Students will:
• record their definitions of what they think they know about volume and capacity;
• estimate the capacity of the classroom;
• consolidate their understanding of volumes of rectangular prisms.</td></tr>
<tr><td rowspan="2">Assessment - Diagnostic</td><td colspan="2">In this lesson you will find out what students already know about volume and capacity. This will allow you to take account of students' existing ideas when planning learning experiences.</td></tr>
<tr><td colspan="2">Assessment task/s
Build rectangular prisms with small (1 cm3) blocks and record their results. Make calculations and establish a formula for the volume of rectangular prisms.</td></tr>
<tr><td colspan="3">Literacy focuses</td></tr>
<tr><td colspan="2">Maths journal</td><td></td></tr>
<tr><td colspan="2"></td><td></td></tr>
</table>

<table>
<tr><td>EXPLORE
(2-3 lessons)</td><td colspan="2">To provide hands on, shared experiences of measuring large capacities.
To support students to investigate and explore ideas that link units of capacity with those of volume.
To support students to determine the areas of irregular shapes based on diagrams in which scale has to be taken into consideration.</td></tr>
<tr><td colspan="2">Lesson numbers 2, 3 and 4</td><td>Lesson titles:
Swimming pool classroom
Volume units and capacity units
Areas of water</td></tr>
<tr><td colspan="3">AT A GLANCE</td></tr>
<tr><td colspan="3">Students will:
re-familiarise themselves with an area of 1 m^2;
participate in a hands on experience that allows them to relate to the actual size of a cubic metre;
determine how many cubic centimetres are in a cubic metre;
estimate and directly measure the volume of the inside of the classroom;
review their definitions of volume and capacity and refine them through whole class discussions;
conduct an investigation to link cm^3, m^3, mL and Litres;
calculate the capacity of the classroom in Litres;
determine the actual areas of reservoirs from scale diagrams.</td></tr>
<tr><td rowspan="2">Assessment - Formative</td><td colspan="2"></td></tr>
<tr><td colspan="2">Assessment task/s
Build a 1 m cube.
Estimate and measure room capacity.
Use calibrated and non calibrated containers of various shapes and sizes, along with rulers and cubes to investigate units of capacity.
Worksheet of scale diagrams of reservoirs.</td></tr>
<tr><td colspan="3">Literacy focuses</td></tr>
<tr><td colspan="2"></td><td></td></tr>
<tr><td colspan="2"></td><td></td></tr>
</table>

EXPLAIN (1 lesson)	▪ *To support students to develop explanations for experiences and make representations of developing conceptual understanding about volume and capacity. To assist them to link* the formula for volume of rectangular prisms with a formula for the volume of prisms with *irregular cross sectional areas.*

Lesson number 5	Lesson title: Comparisons and Calculations

AT A GLANCE

Students will:

- reflect on previous activities;
- establish a formula for the volume of prisms with irregular cross sectional areas;
- review and consolidate understanding of relevant units and prefixes;
- calculate, given average depths, the capacities of reservoirs;
- compare the classroom's capacity to those of the reservoirs of Lefroy Brook Weir, Big Brook Dam and other dams;
- be introduced to the concept of flow rate.

Assessment - Formative	In this lesson you are looking for evidence that students are developing an understanding of capacity and its measurement; through their use of appropriate units, estimation, direct measurement and calculations based on linear measurements. You should also look for evidence of students' use of appropriate ways to represent what they know and understand about volume and capacity and give them feedback on how they can improve their representations.
	Assessment task/s Capacities of reservoirs worksheet. Reservoir comparison data sheet.

Literacy focuses

<table>
<tr><td>ELABORATE
Graphing
(1-2 lessons)</td><td colspan="2">▪ To challenge and extend students' understanding of volume and capacity by supporting their investigation of flow rates through graphing and interpreting data.</td></tr>
<tr><td colspan="2">Lesson numbers 6 and 7</td><td>Lesson title
Graphing and Interpreting - Parts 1 and 2</td></tr>
<tr><td colspan="3">AT A GLANCE</td></tr>
<tr><td colspan="3">Students will:
review the key features of bar graphs and line graphs;
construct bar graphs of annual catchment rainfall and the Lefroy Brook flow rates;
compare the graphs and interpret the results;
construct a line graph of pipe flow rates v pipe diameter (and/or cross sectional area);
interpret the results.</td></tr>
<tr><td rowspan="2">Assessment - Summative</td><td colspan="2">In lessons 6 and 7 you are looking for evidence about the extent to which students have achieved the Level 4 Chance and Data outcomes:

Students will be able to:
- display data in bar graphs where the axis is labelled with discrete categories;
- produce a graph using the vertical scale to help them plot data points, given a horizontal axis showing the progression of time.

Students will be able to
- read the information provided on axes of bar and line graphs;
- interpret and report on information provided in line graphs, describing trends in data informally.

You will also be able to monitor progress towards Level 5 Chance and Data outcomes.</td></tr>
<tr><td colspan="2">Assessment task/s
Data sets and graph paper.</td></tr>
<tr><td colspan="3">Literacy focuses</td></tr>
<tr><td colspan="2">Line and bar graphs</td><td></td></tr>
<tr><td colspan="2"></td><td></td></tr>
</table>

<table>
<tr><td>EVALUATE
(1 lesson)</td><td colspan="2">▪ To provide opportunities for students to review and reflect on their learning about capacity and flow rates and demonstrate their understanding of the mathematics behind these concepts by applying problem solving skills to a hydroelectric power station scenario.</td></tr>
<tr><td colspan="2">Lesson number 8</td><td>Lesson title
Connecting it all together</td></tr>
<tr><td colspan="3">AT A GLANCE</td></tr>
<tr><td colspan="3">Students will:
• describe volume, capacity and flow rate;
• determine the area of a catchment, given a scale diagram;
• determine the volume of water falling in the catchment, given average rainfall data;
• calculate the average annual flow rate of a stream (m^3/s), based on a percentage of the rainfall received by the catchment making its way to the stream;
• use calculated stream flow rates to determine how long it would take to fill a reservoir, based either on a rectangular prism with stated dimensions or irregular prism with given surface area and average depth;
• graph and interpret data. Possibilities include: flow rate verses kinetic energy; head verses potential energy; kinetic energy through turbine verses electrical energy generated (to investigate efficiency of hydroelectric power system).</td></tr>
<tr><td rowspan="2">Assessment – Summative</td><td colspan="2">In this lesson you will be looking for evidence that students have achieved Level 4 outcomes.
You will also be able to monitor progress towards Level 5 outcomes.
This lesson also provides an opportunity to look for evidence of students' achievement of level 4 or 5 outcomes of working mathematically.</td></tr>
<tr><td colspan="2">Assessment task/s
Worksheets to include: scale diagram of reservoir, average rainfall data, stream flow as percent of rainfall, reservoir dimensions, data sets and graph paper.</td></tr>
<tr><td colspan="3">Literacy focuses</td></tr>
<tr><td colspan="2"></td><td></td></tr>
<tr><td colspan="2"></td><td></td></tr>
</table>

Lesson 1 - Cubic combinations

AT A GLANCE

- To capture students' interest and find out what they think they know about volume and capacity.
- To elicit students' questions about volume and capacity.

Students

- record their definitions of what they think they know about volume and capacity;
- estimate the capacity of the classroom;
- consolidate their understanding of volumes of rectangular prisms.

Assessment focus - Diagnostic

In this lesson you will find out what students already know about volume and capacity. This will allow you to take account of students' existing ideas when planning learning experiences.

Key lesson outcomes for Mathematics

Students will be able to

- record their definitions of what they think they know about volume and capacity and share their ideas through discussion;
- build rectangular prisms of specified volume using small (1 cm^3) blocks;
- measure dimensions and record their results in a table;
- perform calculations and interpret data;
- establish the formula for the volume of a rectangular prism;
- estimate the volume inside the classroom.

Equipment

FOR THE CLASS

- an enlarged copy of 'Cubic combinations'.

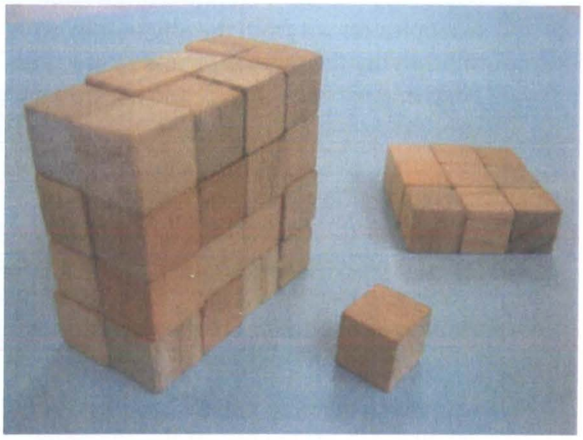
FOR EACH STUDENT

- each students' mathematics journal;
- 1 copy of 'Cubic combinations' for each student;
- approximately 40 small (1 cm^3) blocks.

Preparation

- Organise copies of work sheet and enough small cubes for the class.

Lesson steps



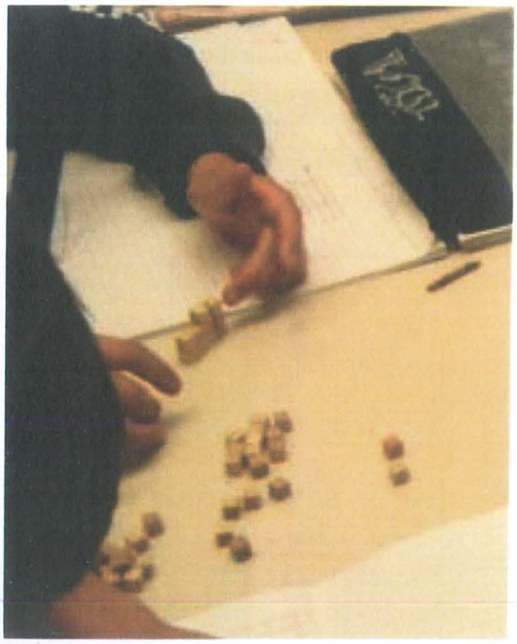
1. Explain to students that in this series of lessons they will be learning new mathematical skills and concepts and how to apply them to the 'real world' situation of hydroelectric power generation. They will be finding out about the mathematics behind reservoir capacities and the flow rates of pipelines and streams. They will be plotting and interpreting graphs and performing calculations involving energy, power and efficiency. In this first lesson they will be learning about volume and capacity.

2. If students aren't familiar with the use of a mathematics journal, discuss the purpose and features with them. Let them know that the journal is for them to date and record their observations, experiences and reflective thoughts and can include photographs, drawings, tables and graphs.

3. Direct students participation in a 'think, pair, share' strategy. The aim of this part of the lesson is to establish a class description of volume and capacity. Initially, ask students to record their own thoughts about volume and capacity in their mathematics journals. Consider prompting them by giving sentence starters; for example, 'I think volume is...', 'I think capacity is...', 'Volume can be measured by...', 'Capacity can be measured by....' and 'Volume and capacity are different/similar because....'

   After a few minutes, encourage students to share their descriptions with their partner. Open up the discussion to the whole class. If possible establish with them a class description of volume and capacity.

It is important in the Engage phase to allow for students to respond and contribute without correcting or providing them with formal definitions. This is an opportunity to gain an insight into students thinking and prior knowledge and to diagnose alternative conceptions and plan accordingly.



4. Use the enlarged copy of 'Cubic combinations' to introduce the activity to the students. Read through the instructions and, with student assistance, construct one of the rectangular prisms and complete the appropriate part of the table as an example.
5. Distribute a copy of 'Cubic combinations' to each student along with about 50 small cubes. Instruct them to glue the worksheet into their journals and begin the activity. Monitor student work; try to discourage students making only Ncm x 1cm x 1cm prisms for N cubes. Encourage students to make at least one prism for every example and challenge them to make as many different combinations as they can think of. Some may see the pattern between prism dimensions and 'factors' to help work out all possibilities. Students can add another couple of examples to the bottom of the table as a challenge to themselves or others.

6. After students have completed the table, use the enlarged copy of the worksheet to record examples drawn from the students to complete the L, W and H columns. By mentally multiplying the three numbers to see if the answer equates to the number of cubes, it is relatively easy at this point to spot errors. Students giving incorrect dimensions can be asked to check their work.
7. Explain to the students that to continue with the activity it is important that they understand how much 3D space one of the small cubes takes up. Remind them of the class description of volume established earlier in the lesson. Through class discussion about length and area, draw on their understanding of 1D (length) units and 2D (area) units to consider units measuring 3D (volume). Use the 1 cube prism example and dimensions to lead them to understand that the volume of one small cube is one cubic centimetre.

8. Instruct students to put the heading L x W x H on the top of the final column and complete the calculations for the rest of the examples. Recording the units of cm^3 in this column isn't necessary at this stage.
9. Ask students to compare the first and last columns of the table and having agreed they are numerically the same, discuss the units generated through this calculation. Use the single cube to establish that 1cm x 1cm x 1cm describes a volume unit of $1cm^3$ (where the 3 represents three dimensions) and state it as a cubic centimetre (which can be abbreviated to cc). Ask students to add cm^3 units to the last column if they have not already done so. Having completed the comparison, facilitate a whole class discussion about the implications this may have for determining the volume of rectangular prisms in general. Instruct students to consider the rule and write a journal entry beginning 'The volume of a rectangular prism can be calculated by.....'
10. Ask students to build additional prisms to ensure their rule always holds – this is equivalent to generating a scientific hypothesis, using it to predict an outcome, and verifying it by experimentation. Through discussion and diagrams, explore rectangular prisms with dimensions that require calculations based on part units. To encourage students to see the value of being able to use the volume formula, have them apply the rule to some large number situations where using cubes or other concrete materials to determine volume would be impractical.
11. Instruct students to estimate the capacity of the classroom in cubic metres and the volume of their own body in cm^3. They will have an opportunity to review and reflect on their estimates in the next lesson using the 1 m^3 skeletal form for comparison. Emphasise that it is okay at this stage if students aren't overly confident with their estimates. Ask students to write a reflective entry in their journals recording what they have learnt in the lesson as well as their estimates if they have made them.
12. Collect up mathematics journals.

NAME____________________

CUBIC COMBINATIONS

Use the number of 1 cm cubes listed to make rectangular prisms containing that number of cubes. Complete the details for the Length, Width and Height of the built prisms in the table below. Remember to specify the units of measurement.

Number of cubes	Length (L)	Width (W)	Height (H)	
1				
8				
9				
12				
15				
16				
27				
32				

Lesson 2: Swimming pool classroom

AT A GLANCE

- To provide hands on, shared experiences of measuring large capacities.

Students will:

- re-familiarise themselves with an area of 1 m^2;
- participate in a hands on experience that allows them to relate to the actual size of a cubic metre;
- determine how many cubic centimetres are in a cubic metre;
- estimate and directly measure the volume of the inside of the classroom.

Assessment focus – Formative

Lesson 3: Volume units and capacity units

AT A GLANCE

- To support students to investigate and explore ideas that link units of capacity with those of volume.

Students will:

- review their definitions of volume and capacity and refine them through whole class discussions;
- conduct an investigation to link cm^3, m^3, mLs and Litres;
- calculate the capacity of the classroom in Litres;

Assessment focus – Formative

Lesson 4: Areas of water

AT A GLANCE

- To support students to determine the areas of irregular shapes based on diagrams in which scale has to be taken into consideration.

Students will:

- determine the actual areas of reservoirs from scale diagrams.

Assessment focus - Formative